Concrete

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Will It Backslide?

By Harvey Whipple
Editor of Concrete

IN addressing the increasingly important manufacturers of concrete building units, it is trite to say that nothing succeeds so famously as success; it is less hackneyed and now more to the point to say that nothing fails so ignominiously as failure.

The tide of masonry construction is sweeping irresistibly along. Is there no stopping it? Those who made their fortunes with such relentless energy in clearing off the timber and sawing it up into boards were, in that very act, the advance agents of promotion for better kinds of building. The lumber kings put in the footings for the modern masonry house. The excesses of timber waste and the parallel excesses of fire waste, through unprotected wooden constructions, have given us, by the inevitable processes of economic adjustment, the concrete block maker's rapid ascendancy in building construction.

From being a byword and a jest of the serious builder, the concrete building unit has come close to equal rank in wall volume with our traditional friend the common brick.

We don't worry so much now about high strengths. The high strengths of quality-concrete are unnecessary—in a sense not even desirable for the purposes of the great bulk of our construction—the walls of dwellings and other small and light use buildings. There are economic ends to be served. The populace demands better homes. It has been taught to expect them. *Production*—block by the million—that is now the consideration. Strength is but one of many desirable qualities in a building material. It must be *available* in a big, broad sense, or its strength doesn't count for anything. Availability means *big production*—big stocks, ready to use are half the battle for favor with builders. The other half is economy of labor and mortar on the job. The concrete unit now has both. To make it *available*, our notions of strength requirements have undergone thorough revision. If a unit is twenty times as strong as its load demands, why should it be stronger?

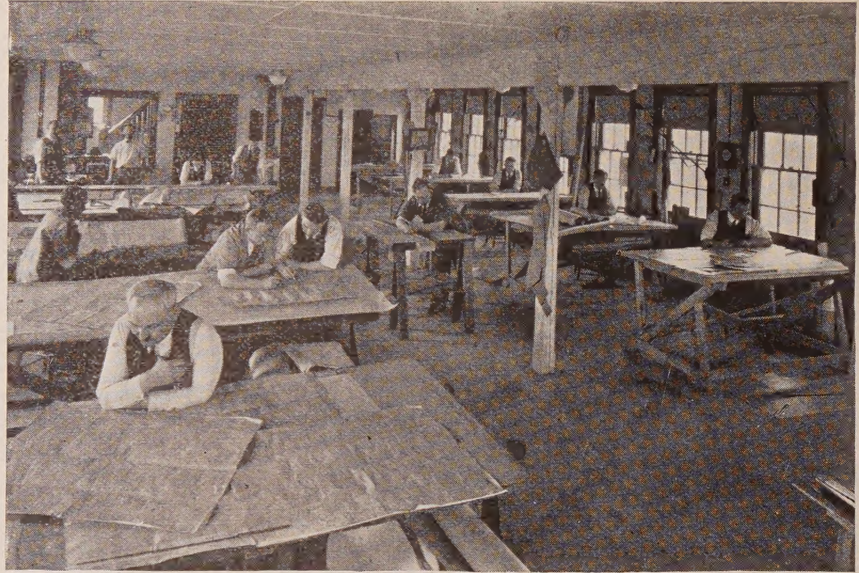
That sort of development is sound enough. Economic service is of more consequence than mere strength—excess strength for its own sake.

So the minimum requirements have been revised downward. Building departments are more sympathetic. Economic availability has overriden suspicion and tradition. This tendency has been hastened also by our increased knowledge of strength and quality control. If we don't have to guess what may be expected of "the mud" in our mixers, we can probably save on the cement.

But there are limits to this sort of thing. The truth is: a lot of bad block are being made and sold and used. The situation is the more serious because, knowing more about what may be expected of a certain mix, and having the general standard scaled down to economic needs, the manufacturer is going skittering along closer to the ragged edge of failure. * * * Nothing fails so ignominiously as failure. "The crime of the Nineties," with its backyard production of sandy, thirsty block, cannot be repeated. That was the crime chiefly of ignorance and incompetence. Now we have been to the inconvenience of getting an education and by dint of honest effort have acquired some efficiency. By such persuasion the block business has been converted to better things. Will it backslide?

Will the men who have hundreds of thousands of dollars in the business stand by and let manufacturers in their own cities "get by" with inferior stuff just because the market will absorb almost anything?

For the prevention of backsliding let the concrete building unit producers support some kind of inspection system on their own work—through some testing laboratory, serving all the producers of a city or district; have weekly or bi-weekly tests made from samples taken off the job. Then will a certificate of quality mean something—quality that is maintained week in and week out—not just once achieved. It becomes a record that everyone may see and soon everyone will know what good units are. This would be a prod to the easy goers and a prickly conscience to the backsliders.



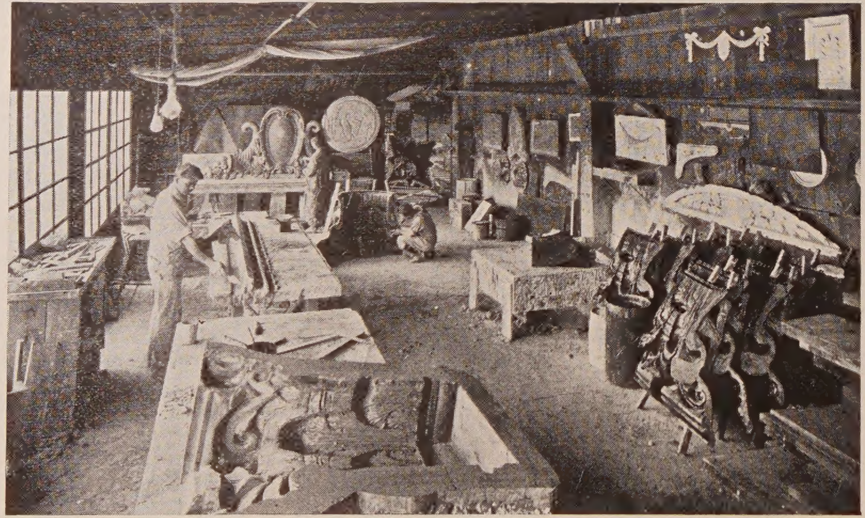
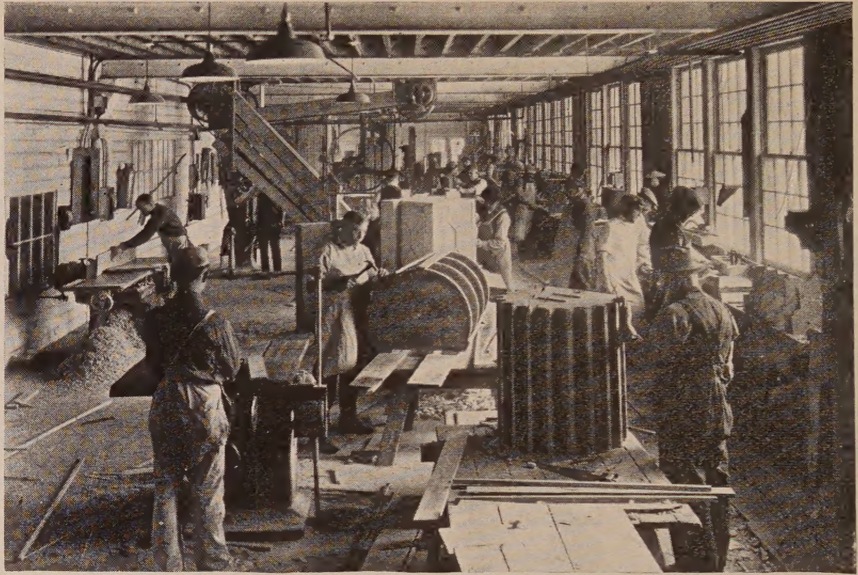
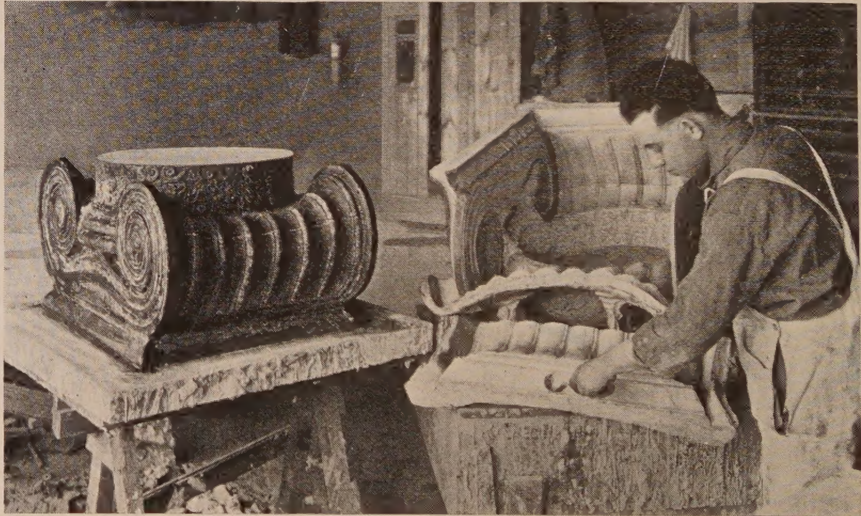


Fig. 1—The Drafting Room Where All Working Plans Are Made and Shop Drawings Turned Out

Fig. 2—A Part of the Woodworking Department Where Wood Patterns Are Made from Detailed Drawings and from Templates Cut to Match the Architect's Full Size Details





Figs. 3 and 4—The Modeling Department Where Special Clay Models Are Made and Where Glue and Plaster Molds and Patterns Are Turned out. In Fig. 3 Just to the Left of Center a Man is Running a Molding of Plaster on a Bench. At the Right Are Sections of a Plaster Mold to Produce an Ornate Capital. At the Left in Fig. 4 is a Model and at the Right a Plaster Mold Which Has Been Made from It

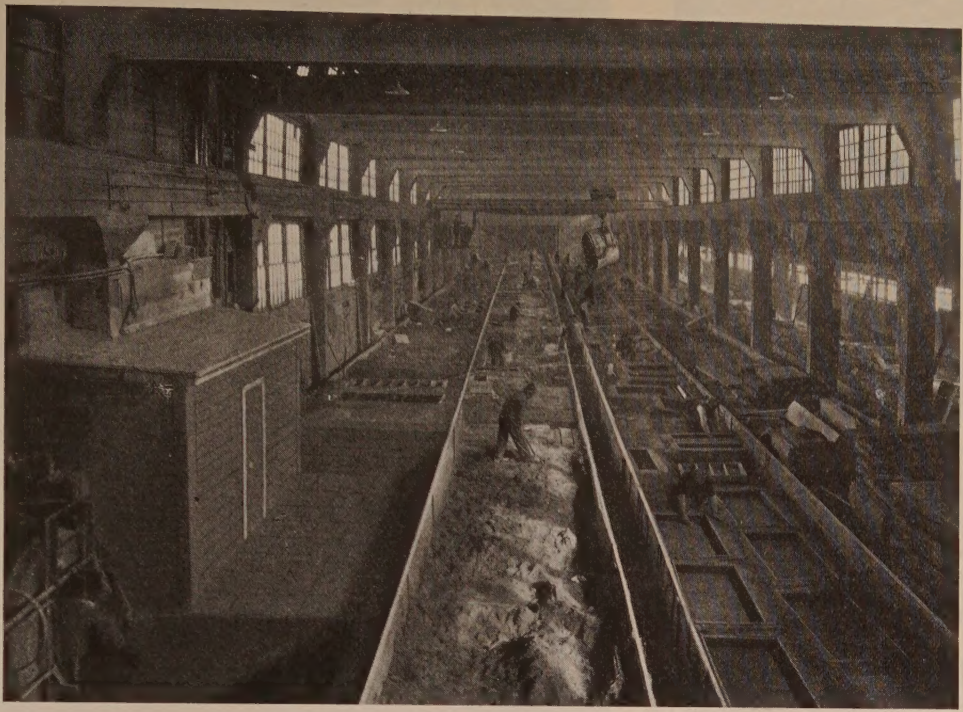


FIG. 5—THE FOUNDRY OF THE ONONDAGA LITHOLITE COMPANY. THE SAND BED IN WHICH THE MOLDS ARE MADE, EXTENDS THE FULL LENGTH AND EVERY PART IS REACHED BY AN ELECTRIC CRANE CARRYING AN ELECTRICALLY DRIVEN AGITATOR WHICH IS SHOWN MORE IN DETAIL IN FIGS. 7 AND 8

Producing a High Quality Concrete Stone

The accompanying illustrations, views of the plant of the Onondaga Litholite Co., Syracuse, N. Y., give a more or less comprehensive idea of operations, organization and equipment involved in a large plant producing high quality concrete dimension and special ornamental stone.

The Onondaga Litholite Co. was established in 1901, and it has a great deal of ornamental and truly monumental work to its credit. There are many kinds and qualities of concrete stone; from the block, tile and brick that are made with standard dimension equipment to meet the requirements of plain walls, backing for face brick and stucco, partitions, bearing walls, curtain walls, on up the scale through face block of standard dimensions and face trim stone, to the products of processes like those by the Onondaga company. This work involves the crushing, screening and recombining of special aggregates, including marble granite; large drafting department; pattern and modeling department; a foundry where much of the work is cast in sand molds; and finishing departments employing heavy machinery in addition to hand tools in doing practically everything with concrete stone that can be done with natural stone of the finest quality, and many things that cannot be done with natural stone.

One of the distinctive things about the Onondaga company's product is the fact that the stone made is of the same material and quality throughout. Face mixtures and back-up mixtures are not utilized. If the aggregate is marble, the stone is marble all the way through; if the aggregate is granite, it is granite all the way through. The Onondaga Litholite Co. has a capacity of 2000 cu. ft. of cut stone per day, or an annual production of 600,000 cu. ft. The product competes over a very considerable eastern territory, reaching out to some extent to the Middle West, with the best of natural stone, and has come to be preferred by many architects not only for trim but for complete structures of a monumental character. It is possible to duplicate the color, texture and surface finish of natural stone where that is the architect's desire, and it frequently is, in additions to natural stone structures where the natural stone cannot now be obtained. It is possible also to produce colors and surface textures which are unknown in natural stone, and of such a quality of material as to cause architects to omit the usual requirements of a waterproof paint on the back of a stone unit.

By the use of reinforcing, as in any other concrete member, it is possible to achieve architectural results which are impossible with natural stone. Each kind and quality of stone is produced under a definite specification, known by number, with the utmost accuracy.

Such an enterprise, producing material of this quality, with an organization of several hundred men and with a capacity for more than half a million cubic feet a year, is interesting at a time when the building industry is so much absorbed in the phenomenal growth in production and use of standard concrete building units. It is interesting and important that concrete meets not only the requirements of utmost economy in standard building units, but rises to the occasion created by architects for the finest structures.

Such is not a business for a small operator. The work involves the employment of a considerable staff of experts in different lines and the use of expensive

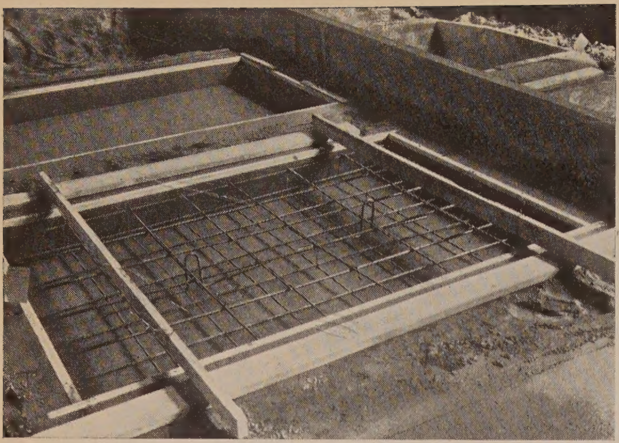


Fig. 6—This Is a Close-Up of the Sand Mold. It Will be Noted That the Top Edges, Which Are Unexposed Edges of the Finished Stone, Are Kept True and Unbroken by the Use of Wooden Strips Set in the Sand. The Edges of the Stone Are Saved from That Irregularity Which Must Result from Minor Accidents to the Edges of the Sand Molds Were They Made Entirely of Sand. It Will Also Be Noticed That Reinforcing is Placed for This Piece, Suspended from a Wooden Framework Resting over the Molds

machinery. To produce a high quality stone by these methods requires a considerable output to meet competition and a considerable organization to meet the exacting demands of an architect who has been used to the finish and texture of the better quality of natural stone.

The operations involved in the Onondaga Litholite Co. plant include those of an engineering and drafting department, which cooperates in reducing to shop drawing the architect's most particular details; a modeling department to turn out special clay models that high class work frequently requires for special pieces; a pattern department to make the patterns for stone when they are to be cast in sand molds, or duplicated in glue molds and the molds of plaster or of glue when the work is of a character which will not admit of sand casting, or where particular results are sought or economy is to be gained by these other casting means.

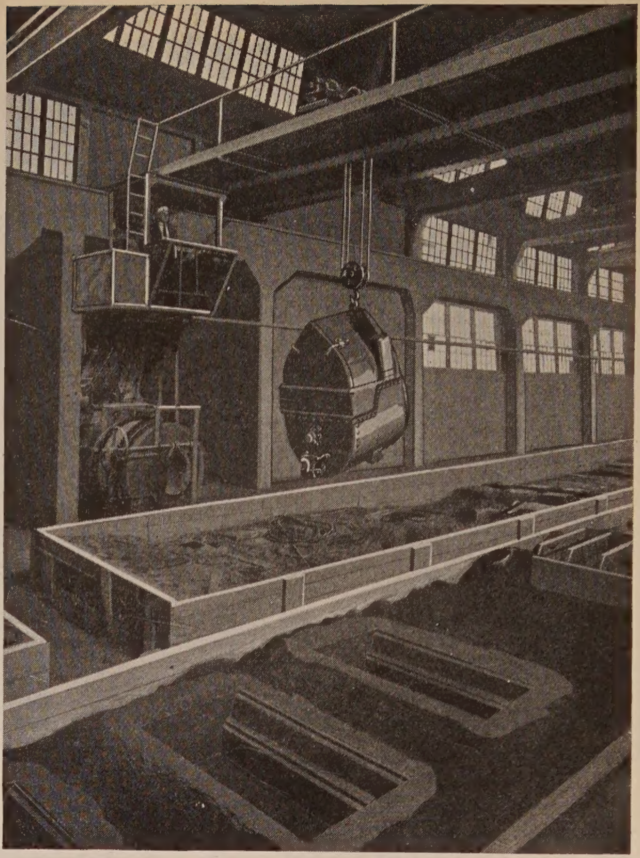
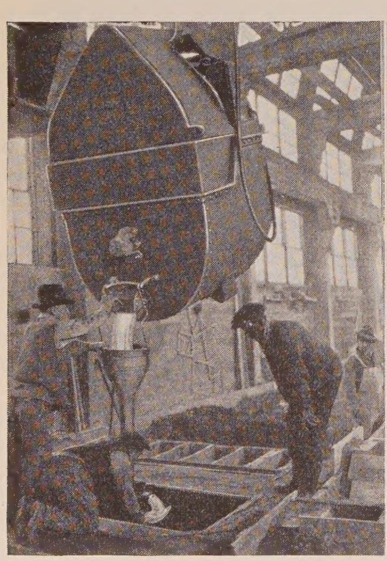
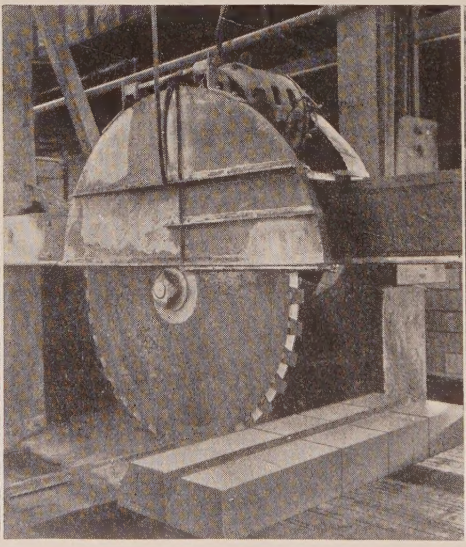


Fig. 7—The Concrete Mixer and the Agitator Which Receives the Concrete from the Mixer and Carries It, by Means of Crane, to Every Part of the Foundry

Photographs of clay models are submitted for architects' approval, or the architect is called in to criticize the modeler's work before the casts or molds are made.

If but one piece is to be made from a special model, a plaster waste mold is made direct from the original model, and after the concrete has been cast and is hard the plaster mold is cut away, the surface of the piece is finished in whatever texture is desired. If





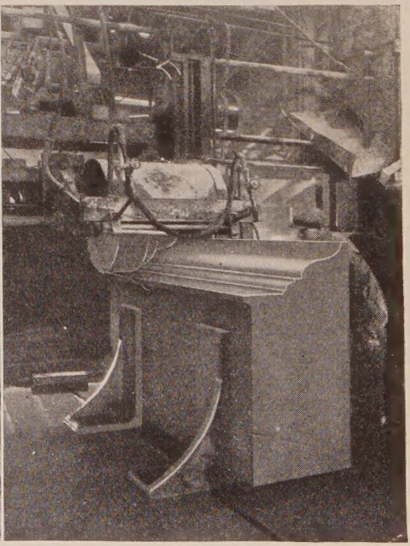


Fig. 8—A Detailed View of Agitator from Which Concrete is Being Discharged Through a Funnel and the Fall Broken at the Bottom by a Trowel in the Hand of One of the Workmen. This Is a Wet Mix, but Due to Long Mixing and Careful Grading of Materials, It Is of a Very Smooth Character with Practically No Segregation of Material. A Special Virtue of Sand Molds Is in the Rapid Filtering Out of the Excess Moisture Which Is One of the Reasons That the Stone Made in This Way Is of Unusually High Strength

Fig. 9—A Saw Cutting up Cast Stone

Fig. 10—This Shows Carborundum Planers Putting the Finish on a Molded Unit. The Factory Has Special Machinery for Turning up These Carborundum Planer Wheels to Produce the Desired Molded Lines

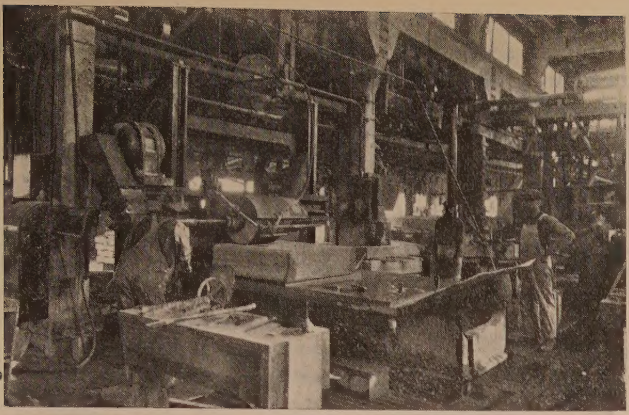


Fig. 11—Extensive and Heavy Machinery Is Employed to Put the Finish on Concrete Stone. In the Center of This Picture a Machine Equipped with Carborundum Wheels is Putting a Smooth or Honed Finish on a Piece of Cast Stone

duplicate casts are required, a glue model is made, following the line of the clay model. This permits making duplicate casts as required by the work. Wood is used for patterns that are made from isometric drawings, a template being taken direct from the architect's detail. The casting is done in what is called the "foundry," where there are long beds of molding sand.

The aggregate comes by rail from a quarry, white and gray-blue marble. It is crushed to about ½-in. size and smaller. It is elevated to a tower and conveyed by gravity through separators, where it is divided in four sizes—½ in. down to dust.

All of the materials going into the stone are weighed for each batch. The mixture is not always the same, and depends upon the particular kind of stone which it is desired to produce. The mixtures come out of the mixer, which is of a slightly modified standard batch type, very wet, and is conveyed, about a 1-yd. batch at a time, into an agitator (see illustration), with a shaft through the center revolving paddles, which are in motion constantly from the time the mixture leaves the mixer until the last of a batch is deposited in the molds. The shaft is driven by a 5 h.p. motor, directly connected with the agitator. The entire outfit is conveyed from the mixer to any part of the shop by means of an electric crane. By this method the material is constantly in motion and in process of mixing from the time it enters the mixer until it is deposited in the molds. Owing to the elevation of the agitator and the weight of the material, the mixture is deposited under sufficient pressure largely to eliminate the possibility of air pockets and to insure a uniform composition of the stone being formed.

Sand Molding

In casting in sand, wood patterns are embedded in sand and withdrawn upward. Undercut is taken care of either by split patterns or by filling in undercut in the pattern and tooling the finished stone. To protect the top edges of the sand mold (the top is usually an unexposed surface of the finished product), wooden strips are put in the sand bed around these edges. In this way it is possible for men to go along a few minutes after the casting is done and trowel off the edges without disturbing the mold. This could not be done with the edges of sand. Furthermore, if the edges were of sand clear to the top, the shrinkage by absorption would be so great as to leave the stone imperfect on the top side.

Color is used on some work, but very sparingly. White is made by using the natural white marble as an aggregate, with ordinary gray cement. The stone with a blue cast is made by using the blue marble to some extent in the aggregate, and a buff stone is made by using a small percentage of mineral color.

After removal from the sand molds, the material is carefully cured out of direct sunlight and as much as possible away from draughts. While curing, the products remain at a temperature within the factory as nearly constant as possible, and are then conveyed by cranes to the department where all faces of the work to be exposed are finished by grinding or surface cutting. When this treatment has been finished, the stone is stored until ready for use. The entire time required to get out an order is usually about 30 days. All pieces of size sufficient to require it are cast with iron anchors and setting hooks in place, and each piece is tagged with the day of casting and the detail number. When the length of any stone is five times

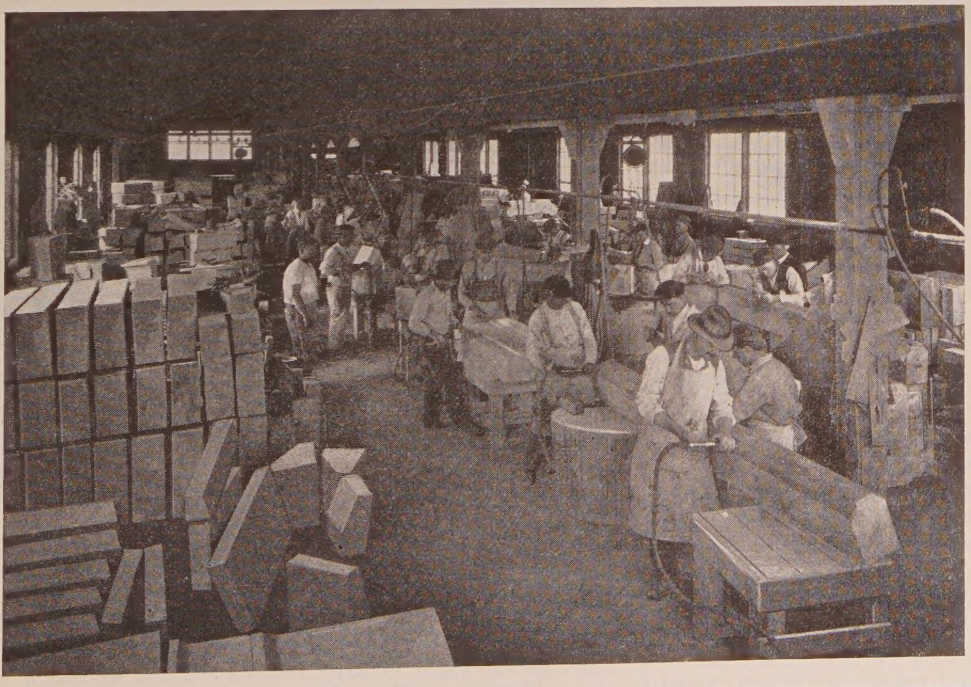
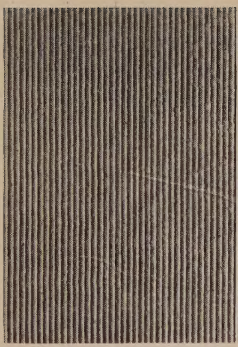


Fig. 12—This Is a General View of the Hand Finishing Department Where Pneumatic Tools Are Extensively Employed



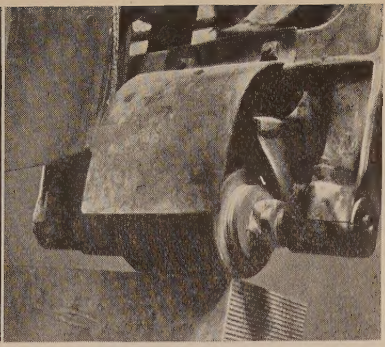
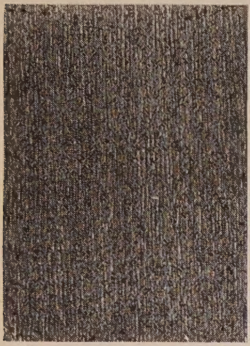


Fig. 13—At Left a Machine Tooled Finish Which is Turned out with Either Four or Six Cuts to the Inch

Fig. 14—At the Right, the Machine Which Does the Work—a Series of Carborundum Wheels Grinding in the Grooves



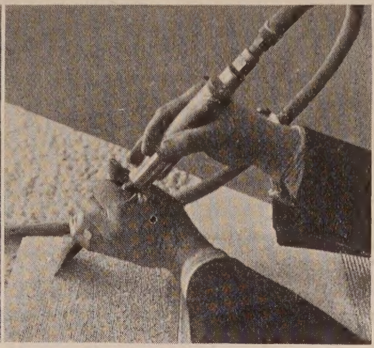
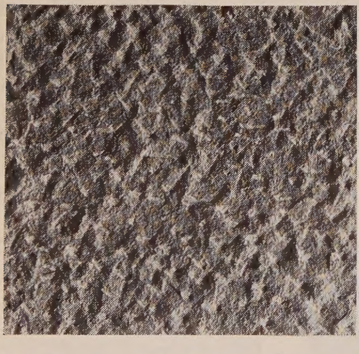


Fig. 15—A Hammer Dressed Finish Generally Used on Cut Cast Granite (Left)

Fig. 16—At the Right, How Pneumatic Hammers Are Used in Producing Cut Cast Granite



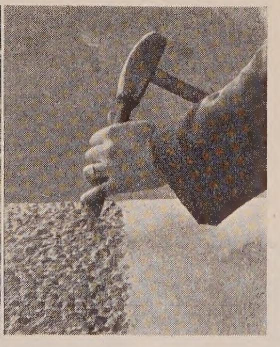


Fig. 17—At Left—A Very Coarse Point Finish Used Where a Rough, Sturdy Appearance Is Desired on the Lower Portions of Large, Massive Buildings

Fig. 18—View at the Right Shows How This Finishing Is Done Using a Single Pointed Chisel

its smallest cross dimensions, it is reinforced to prevent breakage in handling, and when the structural design calls for added strength it is reinforced as required.

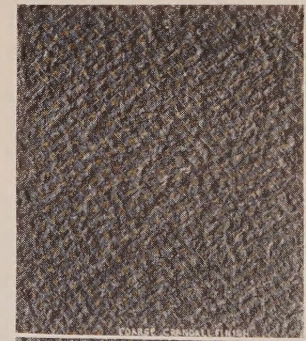
Finishing

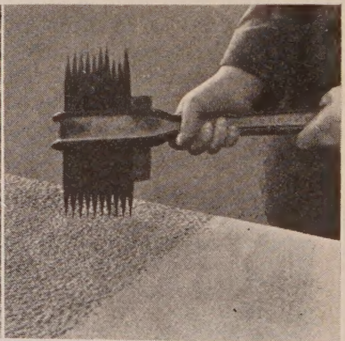
When the stone comes out of the sand molds, it is frequently very rough from sand containing some cement which has adhered to the product. About 24 hours after being cast, however, it is gone over with rasps, scrapers and wire brushes in the hands of common laborers. The sand adhering to the surface is removed, the rough spots are taken off.

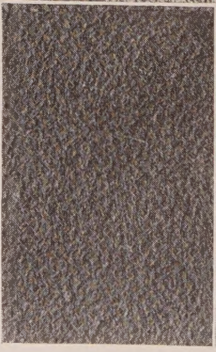
The stone is cured sowly. After proper ageing, it is finished by recutting all exposed surfaces, either by hand or by machinery. Carborundum cutting tools are extensively employed, and carborundum planers for removing the surface and producing a hone finish. When a considerable length of stone is to be employed of a given section, it is frequently cast in lengths and sawed up. In finishing its product, which the Onondaga Litholite Co. calls "cut cast stone," the work is practically the same as in a natural stone plant from the time the rough casts are sufficiently aged for cutting.

In a great deal of large work it is possible to use cores, making a much lighter unit than is possible with natural stone, lowering the cost of freight and the cost of handling. This method has been used in cornices and in sections of large columns. Lifting hooks are cast in all stones for ease in cutting and handling. Conduit for electric wiring can be cast in the stone if desired. If stone is to be suspended from structural steel, the necessary bolts and hangers can be cast in the stone. L-shaped blocks can be cast for use in corners, giving a massive effect without excessive weight. If damage occurs on the job, stone can be repaired, using a mix identical with that employed in the original concrete, and the surface tooled to match the original piece.

Each particular stone is first drawn up on a card on which necessary information is supplied in the drafting room. On leaving the drafting room the card is entered up on a bill-of-material sheet and forwarded to the pattern department. The card contains sufficient information, together with template or full-sized detail, if either is required, to enable the pattern shop to get out the pattern. The card is then turned over to the finishing department for future use. The pattern foreman makes out molding tickets. These are sent to the molding department, together with the pattern, one ticket for each style of stone. These tickets are made in various colors, signifying to the men who pour the stone the particular mixture or color. These are stuck in the sand, and when the







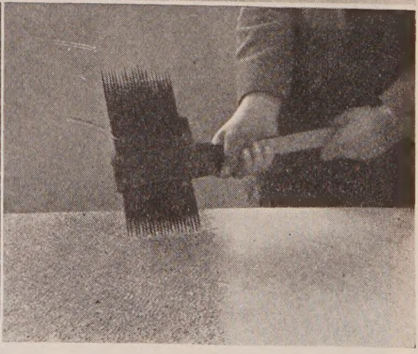


Fig. 19—Left—A Coarse Crandall Finish, Also Used for Heavy Work

Fig. 20—At the Right, the Heavy, Pointed Teeth Lined up in a Tool Operated by Hand by Means of Which This Coarse Crandall Finish Is Produced

Fig. 21—Left—A Fine Crandall Finish. A Similar Finish Is Used Extensively on Some Natural Stone

Fig. 22—The Finer Pointed Teeth by Means of Which This Finish Is Applied by Hand

stone is poured inserted in the wet concrete by means of wires. These tickets give to the molding room all the information required in regard to reinforcement, setting hooks, etc. They also give the molder's name, and make it possible to check up any inferior work and place the blame on the proper man.

Patterns must be so made as to be withdrawn from the sand without breaking down the mold. This is best shown in an illustration. Take, for instance, the piece of stone shown in Fig. 23, with the parts clearly indicated. It will be seen that the pattern is in four parts. The molded side is placed downward in the sand, and when the sand has been tamped into place, the pattern is drawn in the direction indicated by the arrow. It is obvious that any side projection in the pattern must be a separate piece and separately withdrawn. If drawn all at once, the projections would break the sand mold. If there were but few such pieces to be cast, it would be more economical—by saving time in making the pattern and in making the sand mold—to eliminate the small pattern part numbered 4, by filling in so that the pattern would draw on that line. The additional detail would then be cut in by stone-cutters. Further illustration of splitting patterns is shown in Fig. 24.

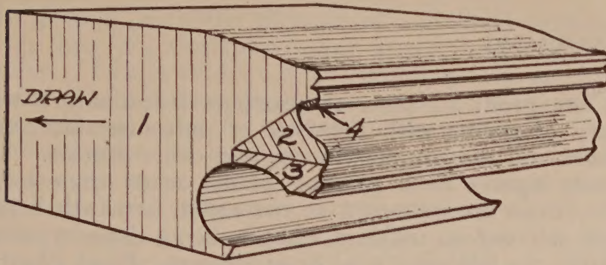


Fig. 23—Split Pattern for Sand Mold

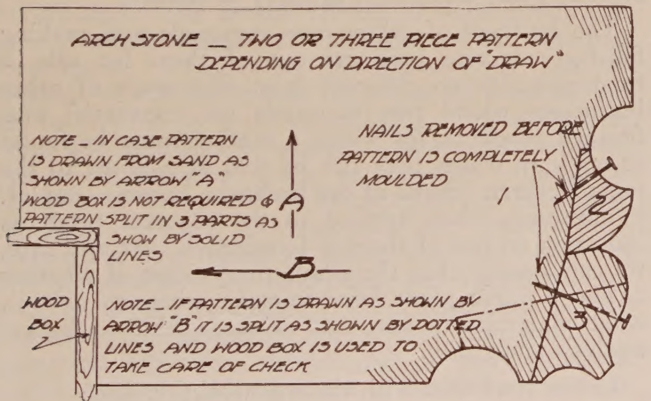

ARCH STONE _ TWO OR THREE PIECE PATTERN DEPENDING ON DIRECTION OF "DRAW"
NOTE _ IN CASE PATTERN IS DRAWN FROM SAND AS SHOWN BY ARROW "A" WOOD BOX IS NOT REQUIRED & PATTERN SPLIT IN 3 PARTS AS SHOW BY SOLID LINES
A
NAILS REMOVED BEFORE PATTERN IS COMPLETELY MOULDED
1
2
3
4
B
WOOD BOX
NOTE _ IF PATTERN IS DRAWN AS SHOWN BY ARROW "B" IT IS SPLIT AS SHOWN BY DOTTED LINES AND WOOD BOX IS USED TO TAKE CARE OF CHECK

Fig. 24—Shows Two Ways of Splitting Pattern for Sand Mold

Balusters, capitals and similar pieces having no large flat surface which may be left upward as the pattern is placed in the sand and toward which the pattern can be drawn, are made by the flask method, in which a box for each of two or more portions of the pattern supports the sand for a section of the mold. The boxes are assembled to complete the mold.

The flask may be comparatively simple, involving the use of but two sections. Sand is sometimes mixed with plaster in such work, because, when the sectional molds have been made in the boxes, the boxes must be fitted together and stood on end. The parts are made to fit precisely by the use of dowels in the sections of the flask or the box, or by cleats which engage at the corners. The flask, as completed, is filled through an opening in the top as made by wood insert.

In making an elaborate capital, it would be more economical to use a gelatin mold, provided a full-size model were available. In this way all the detail and undercutting could be fully brought out. If one section of hexagonal figure were available, it would be enough from which to produce a sand mold by the flask method, but the numerous sections of the flask and the resulting joints frequently give trouble. The use of two sections of the figure would be desirable so that a mold could be in but three sections. In this case, much of the undercutting would be filled in on the pattern sections, and the reverse molds would be made of a mixture of sand and plaster. The three sections, each being a reverse mold of two sections, could be placed together to make the mold. The three sections of mold when placed together would be backed up with sand to hold them securely.

The following is from a description of a flask mold by Walter O. Brown.[1]

> One-half of a pattern is placed on a board in position to receive the "drag" half of the flask. See various steps in Fig. 25.
>
> At the top is shown the drag placed on the "follow board." This box is made big enough to allow at least three inches of sand around largest part of pattern. Bars (center) are not necessary in the drag, as no lifting is done—simply rolling. After the drag is rammed with sand around the pattern, this half of the flask is rolled over and joints are slicked up, then the "cope" (center) is put on the drag and held in place by pins, as shown. Before starting to run the cope a "parting" must be made, which can either be done by a little coarse sand or a piece of newspaper.

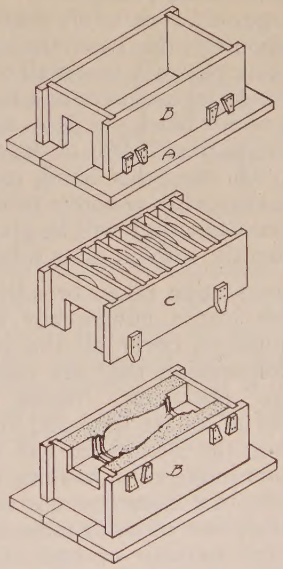


Fig. 25—Making Flask Mold

> In the sketch (bottom), the drag has been rolled over and the cope is about to be lowered. The bars shown in the cope are required when lifting from drag, and they should be made within one-half of the pattern, and beveled to a sharp edge, otherwise that half of sand will fall off.
>
> When cope and drag have been joined, cope rammed with sand, the two parts separated and pattern removed, the halves of the flask are again joined and clamped and the flask stood on end to be filled with concrete through the opening shown. The mixture should be wet and well agitated until poured so there will be no separation of coarse from fine materials. The pouring is done through a funnel nearly touching the bottom of the mold.

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[1] Concrete, February, 1917, p. 76.

Exchange your used ideas for new ones—write to Concrete.

Study Conditions Before Building a Products Plant

By William F. Lockhardt

Concrete structural units are being made and sold at a substantial profit in many cities. Their use is growing rapidly. In two eastern states alone the capacity of existing plants is close to 130,000,000 block per year, all of which the market is absorbing.

This output, however, is from a multitude of comparatively small plants, located principally in the larger cities. In many other cities where concrete products are not being made at all, or in the larger towns where they are being made only on a small scale, (in the individual plants) the field is open to the man who will bring to the industry modern ideas and methods.

One of the chief drawbacks to the industry in the past has been small scale production. While there are cases where a large output certainly cannot be absorbed, it is more frequently the case that the individual capacity of existing plants is too small to get consideration from the builder or architect of a big job. A plant with a capacity of 500 block per day cannot well solicit orders for jobs requiring 20,000 or 40,000 in a limited period of time. On the other hand, it has repeatedly been found true that when concrete products are available in large quantities they will be given serious consideration, frequently without sales solicitation.

Small scale production taken broadly, though, may mean more than just a numerically limited output. It may be applied to cover all the business sins of omission and commission that are usually associated with a "one-man" operation. Among these sins may be listed: lack of adequate finances; the choice of an improper location; the manufacture of the wrong type of unit; use of poor judgment in making the preliminary determination of plant capacity; use of faulty or improper aggregates; use of unsuitable machinery and equipment; faulty methods of handling, mixing and curing; poor upkeep of plant and equipment; failure to keep accurate costs; inefficient control of manufacturing operations; neglect to advertise or use modern selling methods, and above and beyond all—lack of the vision to see in the industry the future that rightfully belongs to it. With this goes also a lack of the aggressiveness to go out and work and plan and fight to make that vision come true. Those few who have had this foresight and courage in the past are now being well repaid, but there is still much to be done, with a commensurate reward for those who have the doing of it.

For those localities in which the demand has been cultivated, concrete products now being made in quantity meet every structural requirement. In addition to the well-known 8x8x16 in. concrete block, brick and lightweight load-bearing tile and non-bearing partition tile have been put into production, and under the right conditions all of them can be made and sold at a profit at a price to compete with competitive materials.

The profit in concrete products manufacture will vary of course with the type of unit manufactured, plant and market conditions, and other factors. To quote figures from existing plants when their local conditions are unknown to the reader is worth little, but in order to indicate what is being done in some plants the following may be of interest. Block plants, with capacities ranging from 3000 to 8000 per day are making net profits of from 3 to 5¢ per block; brick plants whose yard cost per thousand is from $10 to $12, are selling 20,000 to 40,000 per day in cities where $18.00 to $22.00 is the price of brick delivered on the job, and tile plants making from 3000 to 3500 per day are getting a yard price of 9¢ with total manufacturing cost well under 6¢.

The point then is: What are the "right conditions" under which the manufacture of concrete products may be conducted at a substantial profit? To this question there can be no hard and fast answer. A large part of the success of any plant must depend upon the vision and ability of the proprietor—the skill and energy with which manufacturing and selling are pushed; in a word, on the personal equation. Assuming this to be favorable, however, much can be done to rob the matter of any element of mystery or chance.

The business of taking raw materials and making finished concrete products out of them for sale is fundamentally no different from thousands of other businesses where raw materials are converted into finished products, for which a market must be found or made in which they can be sold at a profit to the manufacturer. Some of the problems become simpler, if anything, when applied to the concrete products industry; no one of them is formidable. At any rate, we can assume that the whole proposition of whether or not to start a plant, what to make, where to make it, what materials to use, etc. is susceptible of logical analysis and study.

Let us start then with these general premises:

1. That concrete products can be made to satisfy all ordinary structural requirements for bearing-wall and partition uses.
2. That under the right conditions they can be made to sell profitably at a lower price than competing materials.
3. That these right conditions are the result of properly suiting the product to the market, and the manufacturing and selling of that product along lines found desirable in other industries.

Only a very sketchy substantiation of premises 1 and 2 has been given here (but such substantiation has frequently been published in these pages and attention is called to other articles in this issue—Editor). It thus becomes necessary to give thought to the "right conditions" mentioned in premise 3.

There are three principal factors involved in the first step of this study that cannot well be separated one from the other. They are:

1. The market for masonry materials.
2. The availability of suitable concrete aggregates.
3. Type of product best suited to capture this market.

A preliminary survey should therefore be made of the town or territory under consideration to obtain as much information on these three subjects as possible.

THE MARKET FOR MASONRY MATERIALS

In general, with the increase of individual earning power there is a tendency to buy materials of a higher quality. This is evident in the building field as elsewhere. There is a steady, definite trend at the present time toward more permanent construction. The economic waste of building with materials on which high maintainance costs will have to be carried year after year is becoming more widely appreciated.

There is also an increasing agitation against the use of frame construction because of it's fire hazard. The annual loss of life and property by fire is causing an increasingly stringent regulation of inflammable construction.

Our rapidly diminishing forest resources, with the strong "save the forest" sentiment which is developing throughout the land, favor masonry construction. Lumber, because of its scarcity, is high in price and low in quality. A building dollar no longer buys a dollar's worth of structural value in lumber.

A construction unit that will make possible masonry construction at a cost not too greatly in excess of frame can expect then to have for a market part of existing volume of frame construction. This can be added to the prospect for a normal masonry market.

The extent of this possible normal masonry market is hard to determine, but a good indication may be had. The market is affected by (a) the annual volume of construction and (b) the supply of materials to fill the demand. The annual volume of construction can usually be determined at the office of the Building department. Frequently this information can be obtained in such shape that the volume of construction can be divided by types of building, i. e., residences, stores and apartments, garages, factories, etc. and by type of construction—frame or masonry. The local Chamber of Commerce or Board of Trade frequently can help. Usually the railroads are interested in establishing new industries along their lines and can give information. The local banks and lending institutions can often give a fair picture of conditions as they see them; piecing together the views of these and other competent observers should give a fairly accurate cross-section of conditions, not only as they are, but as they are likely to be in the future.

In making such a survey of the territory in which it is proposed to locate a products plant, it is often helpful to have a form of questionnaire to fill in. While it is often unnecessary to make a detailed study of all the items on such a form as is given below, it is well to remember that a careful study of conditions such as is required to fill in this or some similar type of report will frequently reveal unsuspected favorable or unfavorable conditions which might otherwise have been overlooked. The thought back of these items can readily be seen.

FORM OF REPORT

Town County State
Report made by Date 192
State

County
City Map (Maps) appended hereto for reference.

Population—U. S. Census—1900—
1910—
1920—

General Conditions

What forms the economic backbone of the town? Is it a residential suburb of a nearby larger city, or is it an independent community? If the latter, is it dependent on any one industry or plant for support, or has it a diversified line of manufactures which are less likely to be affected all at the same time in the event of a business depression?

What has been the record of these local industries? Is their product still in full demand, or is it being supplanted by other materials? Have they been growing steadily and normally with the nation's business, or have they been erratic? Are their products basic necessities for which there is a reasonably steady demand, or are they luxuries, the consumption of which stops in dull times? What is the present trend? Is business good? Is production being increased or curtailed? Have labor troubles been a disturbing factor? (These items all have a bearing on the growth and future of the community in which the interests of the products manufacturer are centered, as he must to a large extent be affected by the same factors which affect the community, even though applied to other businesses than his own, for it is on those businesses that the town depends for a livelihood.)

If a residential community, these same factors as applied to the nearby industrial community have almost the same value. Consideration must also be given the present trend of growth—it's type and direction. In what directions are the best paved roads and streets? Best rail or bus services? What is the consensus of opinion of competent disinterested observers regarding future direction of growth?

STRUCTURAL CONDITIONS

Is there a Building Code? When was it written? Are concrete products admitted for use on a favorable or restricted basis? Is licensing and periodical testing required? Is code enforced? What is the attitude of the inspector toward concrete products? Are local products of good or poor quality?

Data on number and types of structures erected within the last few years are likely to be misleading because of the unusual conditions following the halt in building caused by the war. If available for a number of years however it may be worth careful study in connection with data contained in "General Conditions." Such data should preferably include number and value of buildings in the principal types somewhat as follows:

Office and Theatres...............No.....$........
Factories, Whses., etc.............No.....$........
Schools, Hospitals, Institutions.....No.....$........
Garages—Private.................No.....$........
Commercial, Service
Stations, etc...........No.....$........
Residences—Apartment............No.....$........
Private..............No.....$........

This information may be further subdivided as to the general character of residence construction, for example, embracing frame, frame and stucco, masonry, masonry and stucco, etc. Is the prevailing type a cheap or a good construction?

How many local Architects? Builders or Contractors? Materials Dealers? Comment if necessary on size, influence, connections or characteristics of the leaders in these three groups.

Industrial Situation

Shipping facilities good? What railroads? Canals? Highways—are roads paved and kept up? Are they open or passable in winter? Any limitations on weight of trucks or number of trailers?

Aggregates. What materials available—sand, gravel, stone, blast-furnace slag, cinders? Character good for concrete work? Available in quantity at all times? Or will it be necessary to maintain a reserve storage against fluctuations in supply? Cement supply. How received—rail, water, truck. Cost of cement and aggregates on siding. Variations in price over last ten years.

Manufacturing Conditions. Hours per day worked by common labor. Is supply low-priced labor available? Wages in 1914, 1917, 1920, 1922 and 1923. Meter rates for water, and electric power. Cost of bituminous and anthracite coal, and fuel oil.

Competing Materials

Any local clay products plants? What type of masonry unit most in use? What is wholesale or carload prices of

- Clay brick per M. f.o.b. cars
- Clay tile—wall bearing—12″ x 12″—8″ and 12″ thick walls
  - partition —12″ x 12″—4″, 6″, 8″ thick walls
  - wall bearing— 5″ x 12″—8″ and 12″ thick walls
- Cement brick per M. at plant
- Cement block per M. at plant
- Cement tile per M. at plant
- Building or concrete sand per cu. yd. delivered
- Crushed stone or gravel ¼″ to ½″ per cu. yd. delivered
- Cement net delivered to job, per bbl.
- High and low prices for above per annum for last ten years

With this information in hand it is possible to get a distinct picture of conditions. We can tell what factors influence the growth of the community and the direction in which they act. We can tell to a fair degree whether the town is likely to suffer mildly or severely in a period of financial depression. The building code conditions under which concrete products will have to be made and used are known, and we have incidentally acquired valuable information on the character and type of possible opposition and competition. Structural conditions may require an investigation such as has been suggested, or they may be sufficiently obvious to render unnecessary anything more than a careful scrutiny of the town from its streets. Available aggregates and manufacturing conditions have been sketched. If it is desirable to go into future conditions with particular care because of keen competing interests, data on labor, materials, and competing products are available. With this at hand, production costs can be figured on the upgrade from 1914 to date,and comparisons established at different times between concrete products and their competitors. As any substantial changes in the more important factors such as labor, fuel, transportation, etc. all affect clay and concrete products to about the same extent, it is reasonably safe to assume that where the comparison shows up favorably in the past it will continue to do so in the future, unless there is a radical overturn in the clay industry.

The clay products manufacturer has fewer available sources of supply than the concrete products man; they are more frequently located some distance from town; larger land areas are required; and as labor, fuel and transportation play a far larger part in the cost of making clay products it is difficult to see how the handicap under which the older industry is operating can be overcome.

The Economical Manufacture of Quality Concrete Products

By E. W. Dienhart
Cement Products Bureau
Portland Cement Association

From a paper presented at the Convention of the Wisconsin Concrete Products Association.

The Structural Materials Research Laboratory, maintained jointly by the Portland Cement Association and Lewis Institute, Chicago, has carried out many thousands of tests to determine the factors which govern the strength of concrete. As a result of these investigations the importance of the several variables that enter the making of concrete are quite definitely established and we now are in possession of the fundamental facts which permit the manipulation of these variables so as to produce concrete of certain specified qualities in the most economical manner.

The test specimens used by the laboratory are 6 x 12-in. cylinders. To make a specimen of that size and shape properly, using standard methods of molding specimens, requires a plastic concrete similar to that which is used for concrete products made by the so-called "cast process." Accordingly most of the tests made at the Structural Materials Research Laboratory apply more directly to concrete employing plastic mixtures.

What Makes Good Concrete

To determine whether or not the principles which have been developed for plastic mixed concrete apply equally well to machine tamped concrete the Portland Cement Association in cooperation with the Structural Materials Research Laboratory carried out extensive field investigations during the past year. Drexel Institute, Philadelphia, and Marquette University, Milwaukee, cooperated in these investigations by making physical tests of the specimen units. Commercial concrete products plants, using their regular equipment and personnel, were employed for this purpose. The owners of these plants also cooperated in these investigations by placing their plants at our disposal without charge. Tests were made on concrete brick at Philadelphia, on concrete building tile at Prairie Du Chien, Wis., and on concrete block at Milwaukee. The writer acted for the Cement Products Bureau, Portland Cement Association, in each case, and Stanton Walker represented the Structural Materials Research Laboratory at Philadelphia and Prairie Du Chien. R. D. Robertson represented the Laboratory at Milwaukee.

As a result of these field investigations we have been able to show that the fundamentals of making concrete developed in the Laboratory for plastic mixtures also apply to the commercial manufacture of machine tamped concrete products employing non-plastic mixtures.

The research work carried out by the Laboratory shows that the strength of concrete is influenced by a number of factors, each of which is important and *any one of which if incorrectly controlled will cause a material decrease in strength.* These factors are:

- Quality of Aggregate
- Grading of Aggregate
- Quantity of Cement
- Quantity of Mixing Water
- Time of Mixing
- Curing

QUALITY OF AGGREGATE

Aggregates should consist of natural sand, or particles of hard, tough, crushed rock, pebbles or other materials suitable for concrete, well graded from fine to coarse. Aggregates should not contain injurious amounts of vegetable or other organic matter, as indicated by the Colorimetric Test, nor more than seven (7)% by volume of silt, clay or other harmful matter. Impurities are objectionable because they prevent concrete from developing its full strength.

The Colorimetric test for organic impurities is made as follows:

> Fill a 12-ounce prescription bottle to the 4½-ounce mark with the sand to be tested. Pour in a 3% solution of sodium hydroxide, until the volume of the sand and solution, after shaking, amounts to 7 ounces. (The solution is made by dissolving one ounce of caustic soda in a quart of water, preferably distilled.) Shake the bottle thoroughly and let it stand for 24 hours. The presence of organic matter is indicated by the color of the liquid. If the liquid is clear or not darker than light straw color, it signifies that there is little if any organic matter in the aggregate and that it is suitable for concrete. If darker than straw color, the aggregate contains injurious amounts of impurities and should be rejected or used only after having been washed and a retest shows that it is suitable.

In any case where this test shows the aggregate to have a high color value, the aggregate should be tested by making concrete from it before definitely rejecting it, because the Colorimetric test does not hold true for aggregates containing peat or lignite. Aggregates containing peat or lignite will show a high color value even though no organic impurities are present. Such aggregates however, where appreciable amounts of peat or lignite are present, generally do not make good concrete due to the poor weathering qualities of concrete made with such aggregates.

The silt and clay test is made thus:

> Fill a 32-ounce graduated bottle with sand to the 14-ounce mark; adding water to the 28 ounce mark, then shaking the contents vigorously for one minute. If more than one ounce of sediment appears above the sand after it has been allowed to settle for one hour it is unsatisfactory for concrete unless excess sediment is removed by washing. This test will not apply to aggregates having coatings of clay or other substances which are not removed by washing. Such coating will prevent the aggregates from bonding properly with the cement.

GRADING OF AGGREGATE

In general, the greater the percentage of coarser particles in an aggregate, the greater will be the strength and the lower will be the absorption of the concrete resulting from equal proportions of cement to aggregate. Accordingly the addition of coarse material to aggregate lacking in it results in either stronger concrete, more economical concrete with regard to its cost of manufacture, or both.

The Structural Materials Research Laboratory, Lewis Institute, Chicago, has developed a simple measure of the grading of aggregates—a "yard-stick" by which its value in concrete can be measured. This "yard-stick" is called the fineness modulus. It is calculated by simple arithmetic from a sieve test or analysis of the aggregate. The sieve analysis consists of finding out the amount of the aggregate held upon sieves of different sizes. The sizes of the sieves and samples of sieve analyses are given in the following table[1].

TABLE 1—TYPICAL SIEVE ANALYSES OF SAND AND PEBBLES

[2]Sieve No.	Size of Square Opening (inches)	Per Cent by Weight Coarser than Each Sieve		
		Fine Sand	Well-Graded Sand	Pea Gravel
100	0.0058	82	97	100
50	.0116	52	81	100
30	.023	20	63	100
16	.046	0	44	100
8	.093	0	25	95
4	.185	0	5	60
⅜	.375	0	0	0
¾	.75	0	0	0
Fineness Modulus		1.54	3.15	5.55

The sieve analyses are expressed as percentages coarser than each sieve. For example, in the case of the well-graded sand, 97% of the entire sample is coarser than the 100-mesh sieve, 81% is coarser than the No. 50 sieve, etc. The fineness modulus is the sum of the percentages in the sieve analysis divided by 100, when the sieves shown in the table are used. The maximum size of an aggregate is considered as the sieve size next larger than that on which at least 15% is retained. (See Table 2).

Trials will show that the same fineness modulus can be arrived at from a great number of sieve analyses. With an equal quantity of cement, aggregates having the *same fineness modulus* will produce concrete of approximately the same strength. Concrete will increase in strength with an increase in the fineness modulus of an aggregate provided the aggregate is not too coarse to provide a workable mix. The maximum permissible values of fineness modulus which will provide a workable mix and result in maximum strength for various sizes of aggregates and proportions of cement are given in the following table:

TABLE 2

Mix	Size of Aggregate													
Cem.-Agg.	0–28	0–14	0–8	0–4	0–3*	0–⅜	0–½*	0–¾	0–1*	0–1½	0–2.1*	0–3	0–4½*	0–6
1–12	1.20	1.80	2.40	2.95	3.35	3.80	4.20	4.60	5.00	5.35	5.75	6.20	6.60	7.00
1–9	1.30	1.85	2.45	3.05	3.45	3.85	4.25	4.65	5.00	5.40	5.80	6.25	6.65	7.05
1–7	1.40	1.95	2.55	3.20	3.55	3.95	4.35	4.75	5.15	5.55	5.95	6.40	6.80	7.20
1–6	1.50	2.05	2.65	3.30	3.65	4.05	4.45	4.85	5.25	5.65	6.05	6.50	6.90	7.30
1–5	1.60	2.15	2.75	3.45	3.80	4.20	4.60	5.00	5.40	5.80	6.20	6.60	7.00	7.45
1–4	1.70	2.30	2.90	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.40	6.85	7.25	7.65
1–3	1.85	2.50	3.10	3.90	4.30	4.70	5.10	5.50	5.90	6.30	6.70	7.15	7.55	8.00
1–2	2.00	2.70	3.40	4.20	4.60	5.05	5.45	5.90	6.30	6.70	7.10	7.55	7.95	8.40
1–1	2.25	3.00	3.80	4.75	5.25	5.60	6.05	6.50	6.90	7.35	7.75	8.20	8.65	9.10

*Considered as "half-size" sieves; not used in computing fineness modulus.

In concrete products the grading of aggregate that will produce the highest strength concrete generally results in a very rough textured product, too rough to be readily salable, consequently some strength must be sacrificed in order to obtain smooth textured surfaces. It will be found advisable in the manufacture of concrete products to use coarse aggregates of the largest possible size because the larger the size of the aggregate the greater the fineness modulus and for a given fineness modulus of mixed aggregate a higher percentate of sand may be used. This will result in a smoother textured product. However, the maximum size of aggregate particles should not exceed one-half the thickness of the thinnest web of the unit.

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[1] Not all sieves will answer the purpose. Sieves for determining fineness moduli are of definite standardized sizes. Addresses of producers of such sieves will be sent by CONCRETE upon request.

[2] These sieves are recommended for sieve analyses of aggregate in the "Tentative Method of Test for Sieve Analysis of Aggregate for Concrete" of the American Society for Testing Materials.

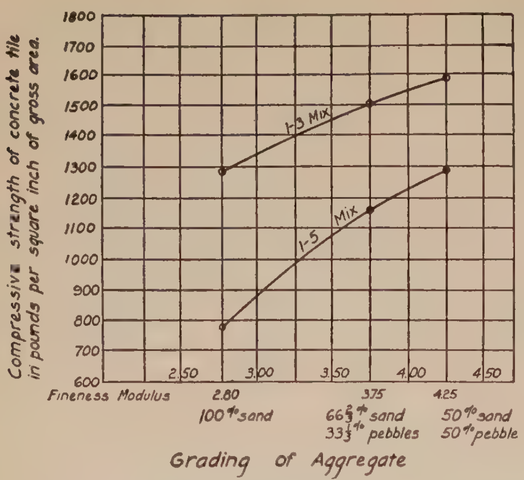


Fig. 1—Effect of Grading of Aggregate on Compressive Strength of Concrete Tile

It has been shown how the fineness modulus is figured from a sieve test or analysis. Frequently a combination of sand or fine aggregate and pebbles or coarse aggregate is used. The two following examples show how to get the fineness modulus of a combination of two aggregates after the fineness modulus of each has been found separately.

(1) Suppose it is desired to obtain an aggregate having a fineness modulus of 4.25 with sand of a fineness modulus of 3.00 and pebbles of a fineness modulus of 5.00. Subtract the fineness modulus desired (4.25) from the fineness modulus of the coarse aggregate (5.00) and divide this number by the difference between the fineness modulus of the coarse and fine aggregates (5.00 – 3.00). This gives the proportion of the fine aggregate in terms of the separated volumes of fine and coarse aggregates.

Thus $\frac{5-4.25}{5-3.00} = \frac{0.75}{2.00} = .375$ or .375 volumes of fine to 1 volume of fine and coarse aggregates measured separately. In other words, 37.5% of the total aggregate is fine and 62.5% is coarse aggregate—or three parts of sand to five parts of pebbles.

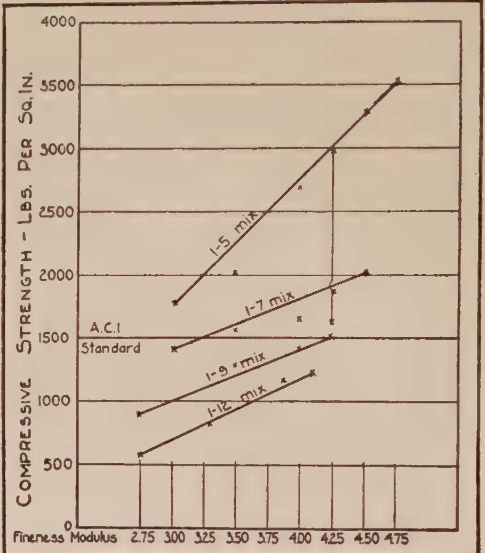
(2) Using the same aggregates as in the first example, find the fineness modulus of a mixture of three parts sand and two parts of pebbles.

Multiply the fineness modulus of the fine aggregate (3.00) by the number of volumes of fine aggregate (3); to this add the fineness modulus of the coarse aggregate (5.00) multiplied by the number of volumes of coarse aggregate (2); then divide this result by the volumes of fine and coarse measured separately as follows:

$$\frac{(3 \times 3.00) + (2 \times 5.00)}{3 + 2} = \frac{9 + 10}{5} = \frac{19}{5} = 3.80$$ the fineness modulus of a mixture of three volumes of sand and two volumes of the pebbles.

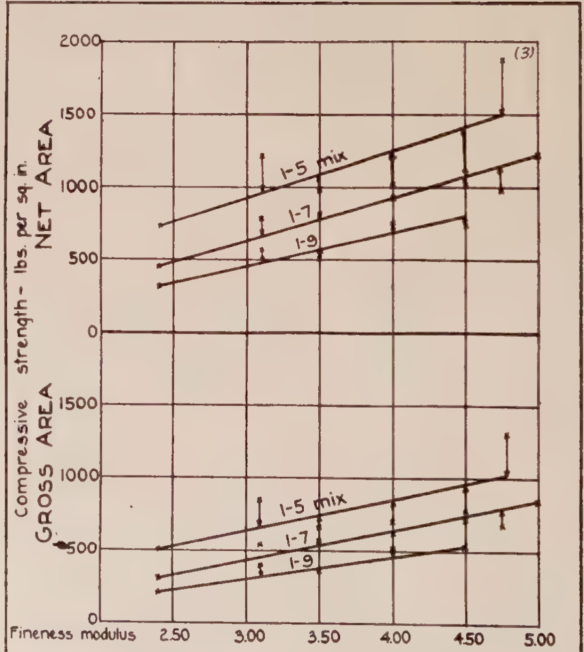
The results of a series of tests on concrete building tile recently carried out at the Lewis Institute show forcefully the advantage of properly graded aggregates in the manufacture of concrete products. The tile were made at a concrete products plant under ordinary but identical operating conditions. The grading of the aggregate was varied by using different proportions of 0 to No. 4 sand and No. 4 to ⅜ in. pebbles. Results from these different gradings used with one part of cement to three parts of aggregate, and with one part of cement to five parts of aggregate are shown in Fig. 1. The compressive strengths in pounds per square inch of gross area are given at the left of the diagram, and the gradings of the aggregate expressed both as fineness moduli and percentages of fine and coarse at the bottom. The tile were tested at 28 days. A strength of 1,280 lb. per sq. in. of gross area was obtained with a mixture of one part of cement to five parts of aggregate (having a fineness modulus of 4.25) composed of 50% of sand and 50% of pebbles. *It was necessary to use a mixture of one part of cement to three parts of aggregate (having a fineness modulus of 2.80) composed of all sand to obtain the same strength.*

The effect of aggregate grading on the strength of concrete is also well demonstrated by the results of



Compression Tests of Concrete Brick
Sand and Pebble Aggregate.
Age 28 days

Fig. 2



Compression Tests of 8"x10"x16" Concrete Block.
Sand and pebble aggregate - air cured.
Age at test - 28 days.

Fig. 3

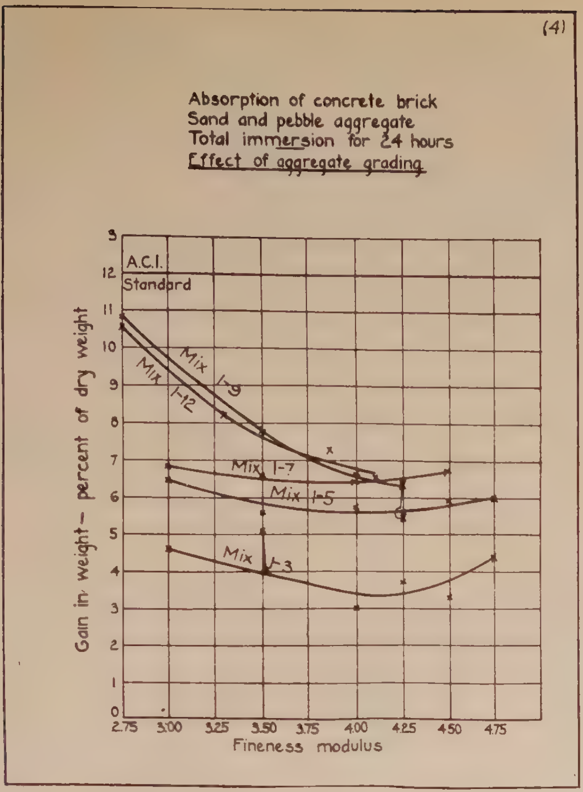


Fig. 4

tests made upon concrete brick and concrete block. Figs. 2 and 3. Fig. 2 shows that to manufacture concrete brick with a compressive strength of 1,500 lbs. per sq. in. when 28 days old, an aggregate of 2.75 fineness modulus would require a 1:5 mix; an aggregate of a fineness modulus of 3.25 would require a 1:7 mix; and an aggregate of a fineness modulus of 4.25 would require only a 1:9 mix. Many manufacturers of concrete brick are using aggregates having a grading of less than 2.75, so it is readily seen that great opportunities are available to those manufacturers to decrease the cost of manufacture by using better graded aggregates. Fig. 3 also shows the same trends for concrete block indicating that concrete block of equal compressive strength were obtained from the following combinations of mix and aggregate grading:

Mix Volumes of Cement to Aggregate	Grading of Aggregate
	Fineness Modulus
1:5	2.40
1:7	3.40
1:9	4.50

The absorption of concrete is also affected by the grading of the aggregate to a degree equal with the influence of aggregate grading on the strength of concrete. Particularly with the leaner mixes, the use of aggregates of high fineness modulus grading will result in much lower absorption than when aggregates of low grading are used. Fig. 4, giving the results of absorption tests on concrete brick, demonstrates this point. The curves show marked decreases in absorption for 1:9 and 1:12 mixes with each increase in the fineness modulus grading of the aggregate. It also indicates that for richer mixes the absorption of concrete brick is more dependent upon the volume of cement used than upon aggregate grading. It will be noted that there is a maximum value of grading, coarser than which an increase in absorption results. This is due to the grading becoming too coarse to give maximum density.

Quantity of Cement

Figs. 1, 2 and 3 indicate the effect of quantity of cement upon the strength of concrete. They show that for a given grading of aggregate that the strength of concrete is dependent upon the quantity of cement used. Compared with the strength of concrete obtained for a 1:5 mix—fineness modulus aggregate grading of 3.75 in each series of tests, following are the percentages of strength resulting from mixes ranging from 1:3 to 1:12:

Mix	Percent of Strength of 1:5 Mix		
	Brick	Tile	Block
1:3		136%	
1:5	100%	100%	100%
1:7	68%		66%
1:9	52%		52%
1:12	44%		

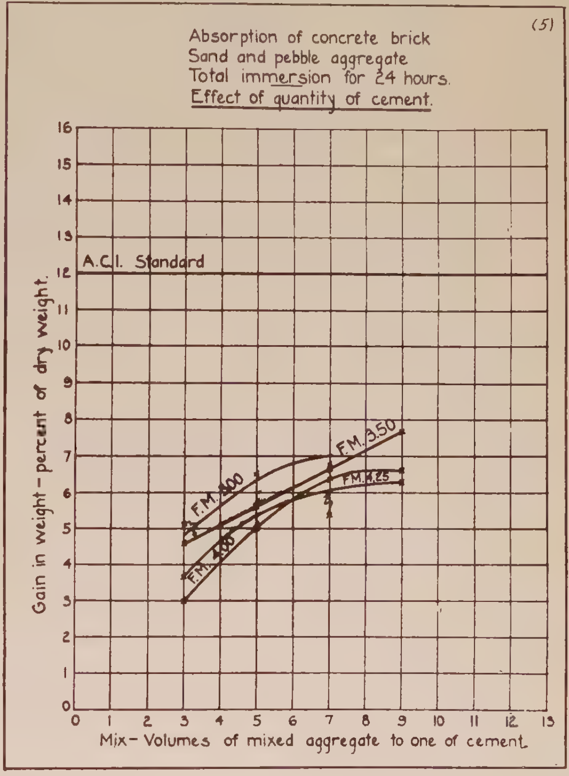


Fig. 5

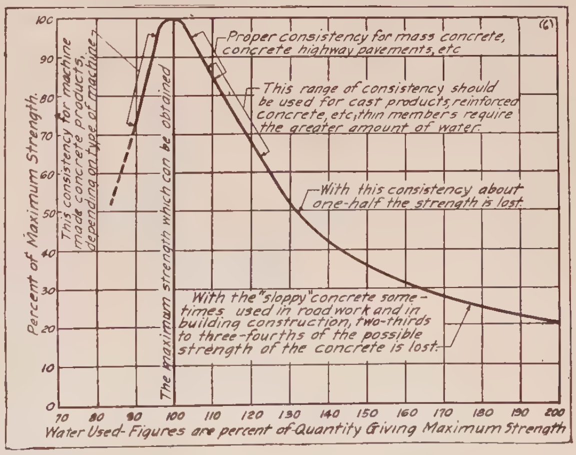


Fig. 6

The quantity of cement used also has a decided influence upon the absorption of concrete. Fig. 5 gives the results of absorption tests made on concrete brick. It shows that for all gradings of aggregate that the absorption of concrete increases with each decrease in the quantity of cement used.

QUANTITY OF MIXING WATER

Our Laboratory investigations have shown that the quantity of mixing water used in concrete is one of the very most important factors in determining the strength of concrete. The accompanying diagram (Fig. 6) shows the great reduction in strength that follows the use of excessive amounts of mixing water. This diagram applies more directly to "plastic" concrete of a consistency required for products of the so-called "wet cast" type where concrete is placed in molds or forms which remain in place until the concrete has hardened sufficiently to permit handling. Products manufacturers employing that method should reduce the amount of mixing water to a minimum which will permit of obtaining a workable concrete, a concrete that will fill the molds without forming pockets or "honey-combing." The use of coarse gradings of aggregate is recommended because less mixing water is required to obtain a workable concrete than where relatively fine gradings of aggregate are used. The use of mechanical equipment such as vibrating machines will also facilitate this process permitting mixes of much stiffer consistency than where the concrete flows into place of its own accord.

A study of the curve of this diagram shows that higher strengths are reached with a reduction of the amount of mixing water up to a certain peak point, beyond which a sharp decrease in strength results. This decrease in strength is caused because the concrete represented to the left of the peak point has become so stiff that it does not provide a workable concrete. Consequently the cement and particles of aggregate do not assume proper relationship, one with the other, the concrete does not become a well compacted, dense mass and strength falls off. Provided mechanical means of placing the concrete are employed which will thoroughly compact concrete of consistencies represented by the left of the peak point, the strength of concrete will continue to go higher until a point where even the mechanical means of placing are unable thoroughly to compact the concrete, then sharp reductions in strength will again follow.

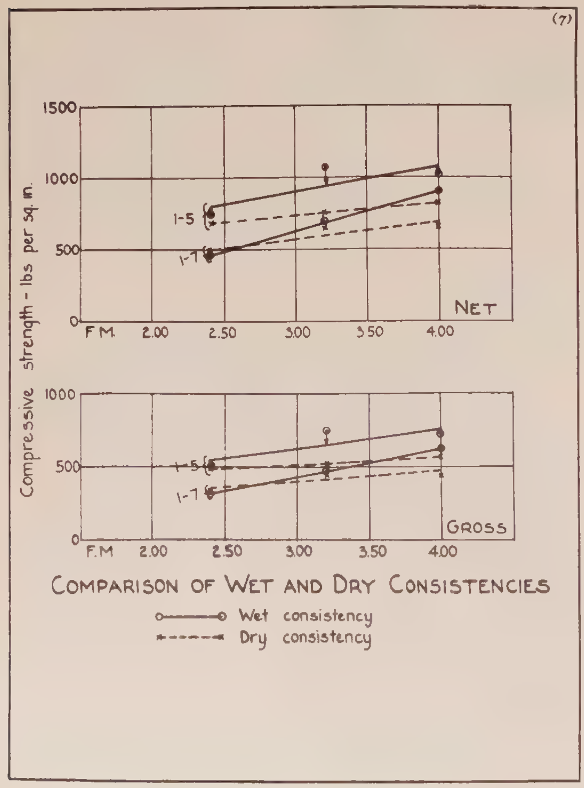


FIG. 7

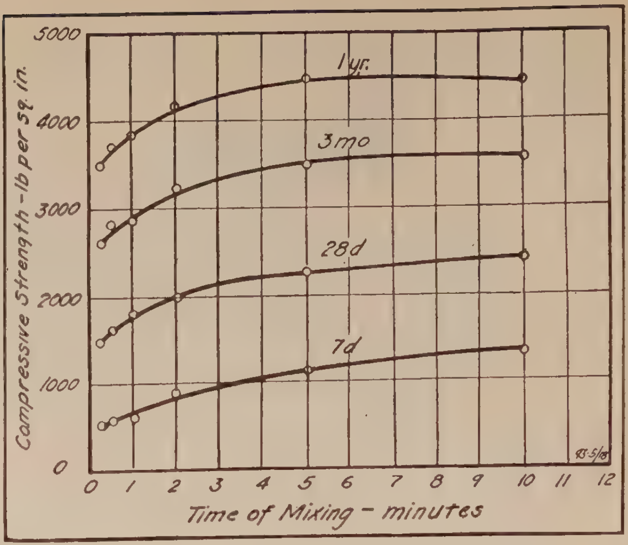


FIG. 8

The left of the curve represents consistencies of concrete which may ordinarily be employed by the machine tamped processes of making concrete products. Concrete products manufactured by this process even though mechanical means of tamping or pressure are used, are generally mixed with too little mixing water to provide a consistency of concrete which will give maximum strength. Therefore it is generally advisable to use consistencies about as wet as the machines can economically handle. Future studies on this point will provide more specific data on this subject. Fig. 7 shows the results of a series of tests made upon concrete block of the machine tamp and pressure type. Two consistencies of mix were employed, one being as wet as the machines would practically handle, the other being considerably drier, using only about one-half of the amount of water added to the batch for the wetter consistency. The curves show that in general the wetter consistency gave higher strengths than the dry consistency.

The same results were obtained from another series of tests made upon concrete block. In this case also the "wet" consistency was as wet as the machine would practically handle. The "damp" and "dry" consistencies were obtained by arbitrarily reducing the amount of mixing water added to the batch for the wet consistency. Except for the web-like markings on the exterior of the block made of wet consistency concrete there was no difference in the appearance of the various block. The following table gives the results of compression tests on the units when 28 days old:

Consistency	Pounds of Water Per Sack of Cement	Compressive Strength Pounds per Sq. In.		Absorption Percent Gain in Weight
		Gross Area	Net Area	
Wet	59	1125	1908	5.5
Damp	51	1025	1732	5.6
Dry	43	917	1550	6.8

The above table shows that for a one-sack batch every additional pound of mixing water used in excess of that required for the "dry" consistency increased the strength 22 lbs. per sq. in. of net area.

TIME OF MIXING

Too few concrete products manufacturers appreciate the possibilities for increases in the strength of their products that may be effected by simply increasing the mixing time of concrete. Fig. 8 gives the results of a series of tests made at the Structural Materials Research Laboratory which show remarkable increases of strength which result from longer periods of mixing time. The following table gives the results of this series of tests and the percentage of increase in strength which was obtained at an age of 28 days for the several periods of mixing time over the minimum period, 15 seconds.

Time of Mixing*	Compressive Strength Pounds Per Sq. In.	Per Cent of Strength of Concrete Mixed for 15 Seconds
15 sec.	1500	
30 sec.	1650	110
1 min.	1800	120
2 min.	2000	134
3 min.	2150	144
5 min.	2250	150
10 min.	2400	160

*Mixing time figured after all materials including water are in the mixer drum.

These tests indicate that marked increases in strength result from increasing the mixing time up to five minutes. Certainly every manufacturer could arrange his process to provide for two to three minutes mixing time. Most plants now in operation have mixer capacity considerably in excess of the capacity of the products machines. Accordingly the concrete should be left in the mixer until the machines are ready for the concrete in place of shutting the mixer down or allowing it to run idle until the next batch is needed.

Plants equipped with continuous types of mixers cannot regulate the time of mixing and accordingly cannot take advantage of the additional strength which increased mixing time makes possible. The performance of continuous mixers could be materially benefitted with regard to mixing time by increasing the length of the mixing trough.

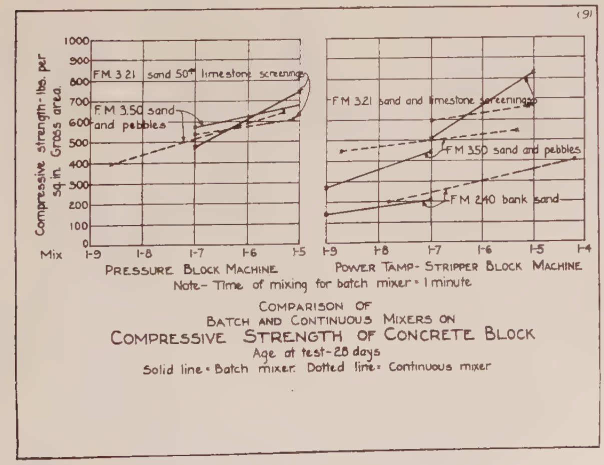
An interesting series of comparative tests on the performance of continuous and batch type mixers was recently made on concrete block in Milwaukee. The scope of this series of tests was very limited and the results cannot be taken as conclusive. Fig. 9 gives the results of these tests and shows that both types of mixers gave approximately the same average results from given volumes of cement and aggregate. However concrete in the batch mixer was mixed for only one minute.

In conducting these tests the cement and aggregates were proportioned for the batch mixer in the regular manner. The fine aggregate, coarse aggregate, cement and water were each measured separately and placed in the mixer. For the continuous mixer the fine and coarse aggregates were first combined to the desired grading by hand shoveling on a concrete floor, then measured into sacks. The correct amount of cement necessary for a given mix was also measured into sacks. The aggregate hopper in the continuous mixer was leveled off with material of the same grading as that to be used in the test, then the predetermined amount of aggregate was added to the hopper. The cement hopper was leveled off and the correct proportion of cement for a given mix was added. The dial on the machine was then arbitrarily set at a point which experience indicated should give approximately the proportion of cement to aggregate desired. The machine was started and when it had consumed all of the aggregate down to the level of the starting point the machine was stopped and the cement hopper was again leveled by either adding or removing the quantity of cement necessary to bring it to the starting level. The proportion of cement used was then readily calculated. The water was gauged arbitrarily to provide a consistency of concrete which was similar to that used for the batch mixer for the same mix and aggregate grading. The water used was measured and generally approximated the quantity of water used for the batch mixer.

The continuous mixer was found to give inconsistent proportions of mix with the different gradings of aggregate used. With the mixer dial regulating the proportioning apparatus set in the two positions noted below, the variations in the resulting proportions are given in the following table:

Proportioning Dial Position	Aggregate		Resulting Mix Volume of Cement to Aggregate
	Kind	Fineness Modulus	
2¾	Bank Sand	2.40	1—4.2
2¾	Sand and Pebbles	3.50	1—5.3
2¾	50% Sand—50% Limestone Scrgs.	3.21	1—5.1
1½	Bank Sand	2.40	1—7.8
1½	Bank Sand	2.40	1—9.2
1½	Sand and Pebbles	3.50	1—8.7
1½	Sand and Pebbles	3.50	1—9
1½	50% Sand—50% Limestone Scrgs.	3.21	1—7
1½	50% Sand—50% Limestone Scrgs.	3.21	1—7

The above table shows that with the proportioning dial set at "2¾" that the variation in proportion of volumes of cement to aggregate ranged from 1-4.2 to 1-5.1. With the dial set "1½" the variation ranged from 1-7 to 1-9.2. The table also shows that the mixer gave quite uniform proportions when the same aggregate was used except in the case of bank sand which



Note - Time of mixing for batch mixer = 1 minute

COMPARISON OF
BATCH AND CONTINUOUS MIXERS ON
COMPRESSIVE STRENGTH OF CONCRETE BLOCK
Age at test - 28 days
Solid line = Batch mixer. Dotted line = Continuous mixer

FIG. 9

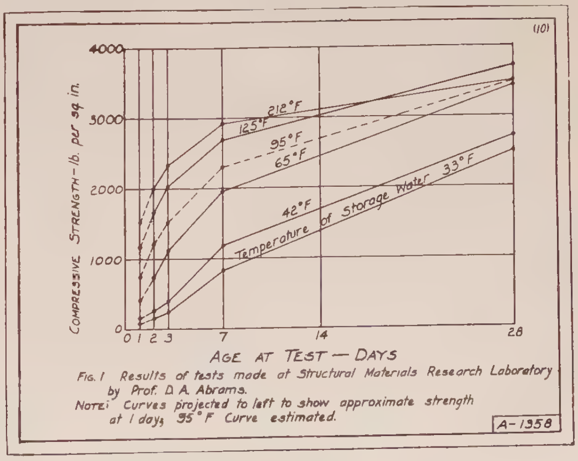


FIG. 1 Results of tests made at Structural Materials Research Laboratory by Prof. D. A. Abrams.
NOTE: Curves projected to left to show approximate strength at 1 days, 95°F Curve estimated.

FIG. 10

gave a very great variation. It is also noted that the trend of variation was not consistent in that with the dial set at "2¾" bank sand aggregate resulted in a much richer mix than for other aggregates. When set at "1½" bank sand aggregate resulted in relatively leaner mixes than for other aggregates.

The results of these tests indicate that considerable variation in proportions of cement to aggregate result from the use of continuous mixers of the type tested unless the aggregate supply is of constant uniform grading.

CURING

The hardening of concrete is due to a chemical action which takes place in portland cement. Moisture is necessary for this action. Hardening stops as soon as concrete is dried out. Heat assists the hardening of concrete, and the concrete attains its strength more quickly in high than in low temperatures. Curing is the process of conditioning concrete during the early hardening period, until it has attained sufficient strength to be successfully used for the purpose for which it is intended. Curing is necessary in the manufacture of concrete products to obtain strength and uniformity of products. The addition of artificial heat hastens curing and permits the products manufacturer to prepare his products for market in the shortest length of time.

The effect of temperature upon the hardening of concrete is shown in Fig. 10. Concrete cylinders, 6 x 12 in. were stored in water at different temperatures and were tested for compressive strengths at various periods up to 28 days. The mixture consisted of one part of cement to four parts of aggregates graded up to 1½ inches. The curves were projected to the left to show the approximate strength of the concrete at one day and a curve for 95° F. temperature was estimated by averaging the two adjacent curves. The diagram shows that concrete one day old cured at 125° F. has the same strength as similar concrete cured for 3½ days at 65° F. and is three times as strong as concrete cured for one day at 65° F. These tests demonstrate the value of steam curing in the manufacture of concrete products for hastening the hardening of the products. Curing at high temperature permits quicker delivery of products to the building site in summer and allows products to be stock-piled outside without danger of harm from freezing sooner in winter than is possible when curing at room temperature.

Quantity Production in George H. Krier's Block Plant

By George H. Krier
Brooklyn, N. Y.

> This article is about the mechanical equipment and layout of a plant with present capacity of 3,300 block per day. Probably Mr. Krier puts undue emphasis on the mechanical part of the business—perhaps through modesty failing to give adequate recognition to the intelligence and integrity which must be fed into the mixer along with the gravel and the cement and water. The best machines don't perform the same for everybody and a less efficient equipment may deliver the goods for an intelligent manager. There are many different ways and there are different machines for big capacity and good quality. The importance of this article is in Mr. Krier's recognition that to compete in a big market the block manufacturer must have big production and a big stock pile and must recognize in the block business an enterprise that requires equipment that will handle a big tonnage with few men—something way beyond the shovel and wheelbarrow reckoning of the early days. A plant can't be ordered out of a catalog. It is an intelligent hitching up of various utilities to the local material and site situation—an engineering problem.—Editor.

The editor of CONCRETE has suggested that the reasons which induced me after eleven years in manufacturing concrete block by both hand tamping and power tamping methods, to build an entirely new plant involving the use of automatic machinery and labor saving equipment throughout, would be of general interest to the readers of this magazine.

Prior to 1922, we had been makng concrete block as an incident to our building supply business, utilizing a small wooden shed in the yard and employing hand machines with two of these machines equipped with power tampers. We had never pushed the block business as such, being content to use the same manufacturing methods that were generally employed by many small plants in this territory.

During the previous year there had been several plants in other sections of Brooklyn, all of which had been constructed in accordance with designs furnished by the Besser Sales Co. of Chicago, and in which automatic, large capacity Besser block machinery had been installed. At that time we were of the opinion that the business would not stand such substantial investments, and that our block were as good and our operating costs as low as theirs.

We kept these plants under observation for a year, and found theirs not only operating at capacity, but getting the business of the large realty developers. We found they were handling single orders for as large quantities of block as had been made previously in an entire year. In short, the quality of the product, and quantity of the output attracted the larger builders; initial orders brought other orders; the economy of properly made block was quickly recognized; and the business took on new life, a new recognition to a heretofore back yard business. One plant which previously had made not much over 60,000 block a year, in its first year of quantity production turned out over a million block and at the same time created a demand for more than four million block. This was a larger block business than we had ever considered was to be had. Not only was this the case, but the block brought top market prices. The combination of incremental feeding and powerful tamping employed on these machines, plus steam curing gave a very hard block. It was preferred by the better contractors and builders. The uniform quality of the block, and their greater strength demonstrated by official tests, opened up uses for block where they had previously been barred.

We observed that these automatic machine tamped block were moving steadily when the yards of the hand tamped block plants were piled high with block. Conversely, we found these plants a stabilizing factor as with their large production, and operation as an all-year-round business, they paid no attention to frantic efforts inaugurated by the small hand plants to cut prices in order to move block when seasonal slumps came, in order to convert stock into money. They continued to operate at capacity, accumulating block which were easily disposed of at regular price levels when demand picked up again. While this was a policy we had always followed, it was of interest to see the concrete block industry conducted along sound business lines. (A big production plant, wherever big production can ultimately be absorbed, and a big stock which can meet big orders, have, in themselves a business-getting influence. A big builder is more likely to "tie up" with that kind of plant than with one run on a hand-to-mouth, eight-months-a-year basis—Editor).

> How Mr. Krier came to view the block business as a big quantity and quality production enterprise is especially interesting in his location—Brooklyn, and other fast growing sections adjacent to New York have had some of the worst block-making conditions to be found anywhere. The bad conditions were not due to "hand machines" but to the hands that worked them. Quality nine times in ten is not a *machine* product so much as it is a product of *material.* Big production is sometimes the only weapon against the evils of small production. The evils of small production are usually the evils that result from the calibre of the manufacturer who continues to vision a big thing as a backyard enterprise.—Editor.

In the latter part of the summer some of our own block were delivered on the same job with block delivered from one of these modern automatic machine plants. It so happened that I visited the job and observed the difference in the quality of the two makes of block. These other block were so much harder and generally superior to our block that I sent our wagon to the job and hauled these other block away, substituting our own block, rather than have the contractor observe the difference for himself. Right then and there we decided that we would either get into the business right and make block that would stand comparison with any block anywhere or we would go out of the business altogether. We had always considered that we made as good block as anyone and prided ourselves on this fact. We realized that times and methods had changed and that block which were good enough when everyone else was using the same kind of equipment we were, were no longer good enough when improved automatic machinery was used by competitors which turned out block as hard at the end of twenty-four hours as our block were when days older.

We spent some considerable time looking into plants in different sections and considered the relative contrasting merits and demerits of various makes of machinery and manufacturing practice. We finally purchased two Besser single automatic block machines and made plant provision for the installation of two additional machines.

We sold ourselves on the proven performance of these machines, and on engineering assistance and service received from Mr. Wightman, engineer of the Besser Sales Co. They made a personal study of our property, after which they designed the plant. The entire plant was built in less than sixty days and when power was turned on the entire plant turned over without a hitch or a flaw or a change being required—no time wasted in experimenting.

In the eleven years we have been in the concrete products business we have visited a large number of plants. We have seen large sums of money expended without achievement of efficient results because not backed with practical knowledge and experience.

Most plants, candidly speaking, are crazy quilts—space is illogically used, the handling arrangements are faulty, and sufficient study has not been given to elimination of labor and removal of congestion.

We feel that we have avoided these common mistakes and have a plant simple in construction and operation, well lighted and ventilated, with plenty of working space and headroom and yet everything is compact and convenient, and not costly to construct.

Based upon observation and experience, we believe proper engineering guidance and assistance in the layout of plant and handling system to be of the greatest consequence to the products manufacturer. Anyone can make things complicated and expensive, but it takes skill and experience to achieve simplicity and efficiency at low cost. Hit and miss methods cannot long survive as against accumulated knowledge and sound engineering judgment. Highly developed machinery will give results when operated with gray matter, and when installed in plants specifically and efficiently planned to contribute to machine efficiency. Lack of recognition of this fact has led to wasted capital, and numerous failures in all lines of business. Most of the plants we have seen have been poorly planned by men who either didn't know how or were incapable of simple planning, or were lacking in knowledge of operating requirements.

Our suggestion to any man seeking to establish a products business is to get competent advice and assistance, and to make sure it comes from men who can prove their practical competence before attempting to build a plant or install machinery. It's easy to start right but mighty difficult to alter and patch an operation that is started wrong. That's why we built a new plant.

Fig. 1 is a plan view of the plant, showing the general arrangement. The building and kilns are of concrete block construction, demonstrating our own faith in our own building units.

Sand and gravel are gathered on the property using a power ½ cu. yard bottomless bucket drag scraper that drags the material from the pit up an incline to a receiving hopper (Lidgerwood hoist[1] and Greene drag bucket[2]). This hopper is built in an elongated trough shape, in the bottom of which is placed a Galion mechanical force feeder,[3] driven from the continuous bucket elevator drive shaft. This

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[1] Lidgerwood Mfg. Co., 96 Liberty St., N. Y. C.

[2] L. P. Greene, Monadnock Blk., Chicago.

[3] Galion Iron Works, Galion, Ohio.

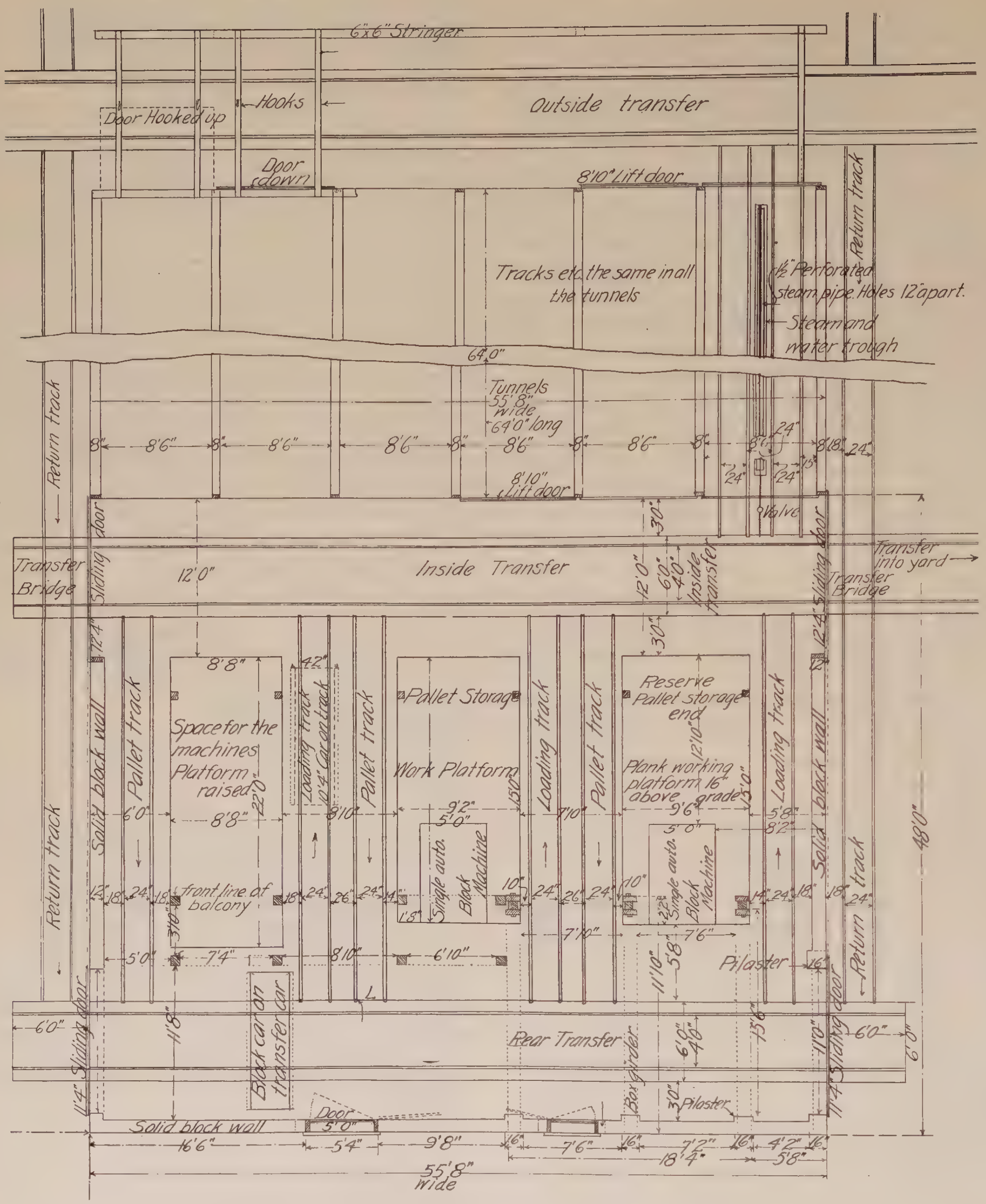

Fig. 1—Plan of Krier Concrete Block Plant, Brooklyn, N. Y.

feeder shovels the sand and gravel into 14 in. Galion continuous chain buckets, delivering a uniform load to the buckets and preventing bridging in the hopper by continuously removing a section of sand from the entire length of the hopper trough. The installation requires no supervision and entirely eliminates a man at the elevator boot as is found in most plants.

One man is required to deliver sand and gravel to the bucket elevator and it takes only two or three hours of his time to fill the storage bin with sufficient material for a day's run. Sufficient bin capacity has been provided for four days operation of the machines, giving leeway against wet sand, etc. In other words labor costing less than $2.00 delivers 50-60 cu. yds. at a cost of less than 4¢ a yd.

In the top of the bin has been installed a Trummel screen[4], 36 in. diameter, 10 ft. long which gives two sizings of material. These are recombined in fixed proportions when delivered to the mixer. Oversize material is discharged through the screen into a wooden spout, which in turn discharges with a bin placed on top of the boiler house. This gives sufficient elevation for gravity loading into trucks. Our sand does not give a very large percentage of oversized material and as there is a ready market for it, we have not had to consider crushing it. The features just described are clearly shown in Fig. 2.

The sand and gravel spouts directly into a Besser 14 cu. ft. mixer for the single block machine on which

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[4] Made to Order in a Local Shop.

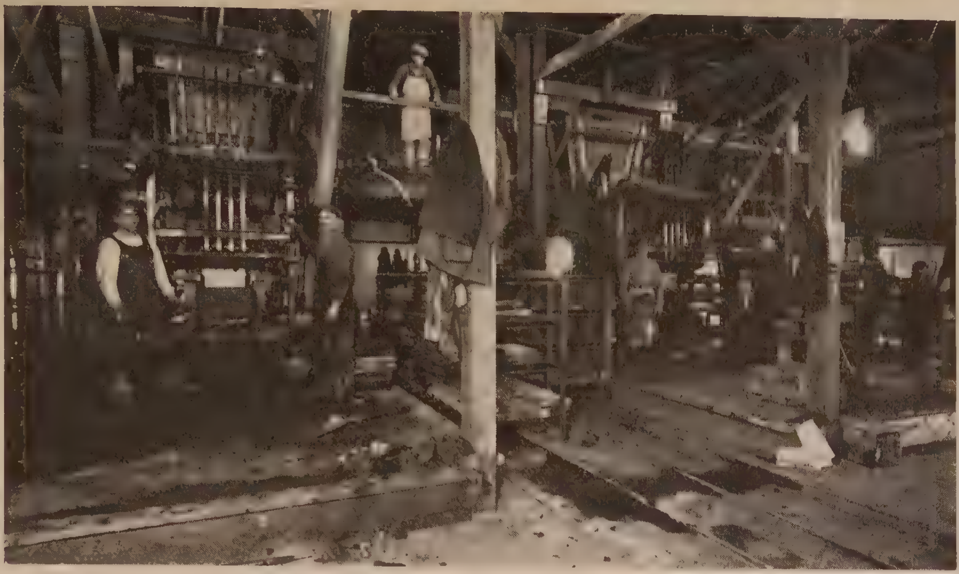

Fig. 3—Machine and Car Levels with Mezzanine for Mixers

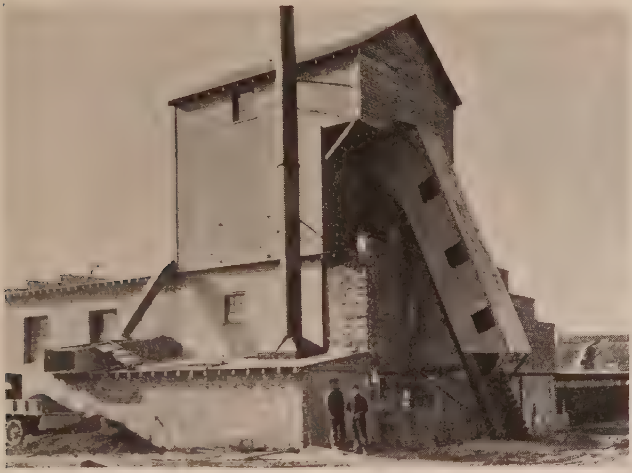

Fig. 2—Elevator and Bin Housing Where Aggregates are Taken in, Screened and Storage Provided for a Three-Day Run

Fig. 4—Storage Yard, Plant in Background

Fig. 5—Opposite View Shown in Fig. 4

we make solid 8x12x16 in. foundation block (Note: In Brooklyn we are compelled to make solid 12 in. block weighing 115 lbs. each for foundation work). We put 95 to 100 tons of concrete per day through this machine. The spout serves as a measuring box, being designed to hold 14 cu. ft. of sand and gravel. Throwing a top lever allows the spout to be filled. The top gate is then closed and when the mixer has discharged the previously mixed batch, the opening of the bottom gate dumps the full measured quantity into the mixer. For the other machine on which 8x8x16 in. hollow and solid (chimney) block are made, a 7 cu. ft. measuring, self-dumping box of special design is used which operates on a Louden over head trolley track[5]. The rail is slightly inclined to the mixer so that gravity carries the loaded bucket from the bottom discharge gate of the bin to the mixer.

One man operates both mixers and does it easily. This man sees to the mixing of 140 tons of concrete per day and does it easily. He has little hard work to do aside from emptying cement sacks into the mixers. Water is controlled by perforated pipes, valve operated, placed over the mixers.

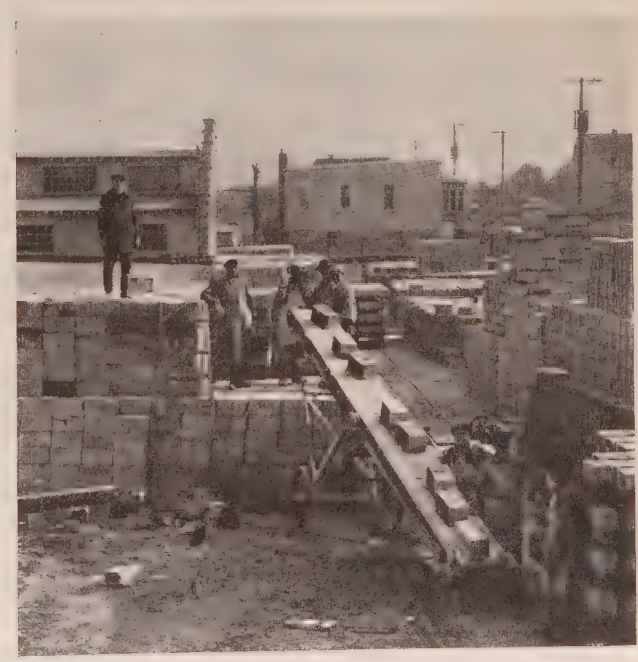

Fig. 6—Belt Conveyors to Left and Gravity Carriers to Convey Block to Trucks

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[5] Louden Machinery Co., Fairfield, Ia.

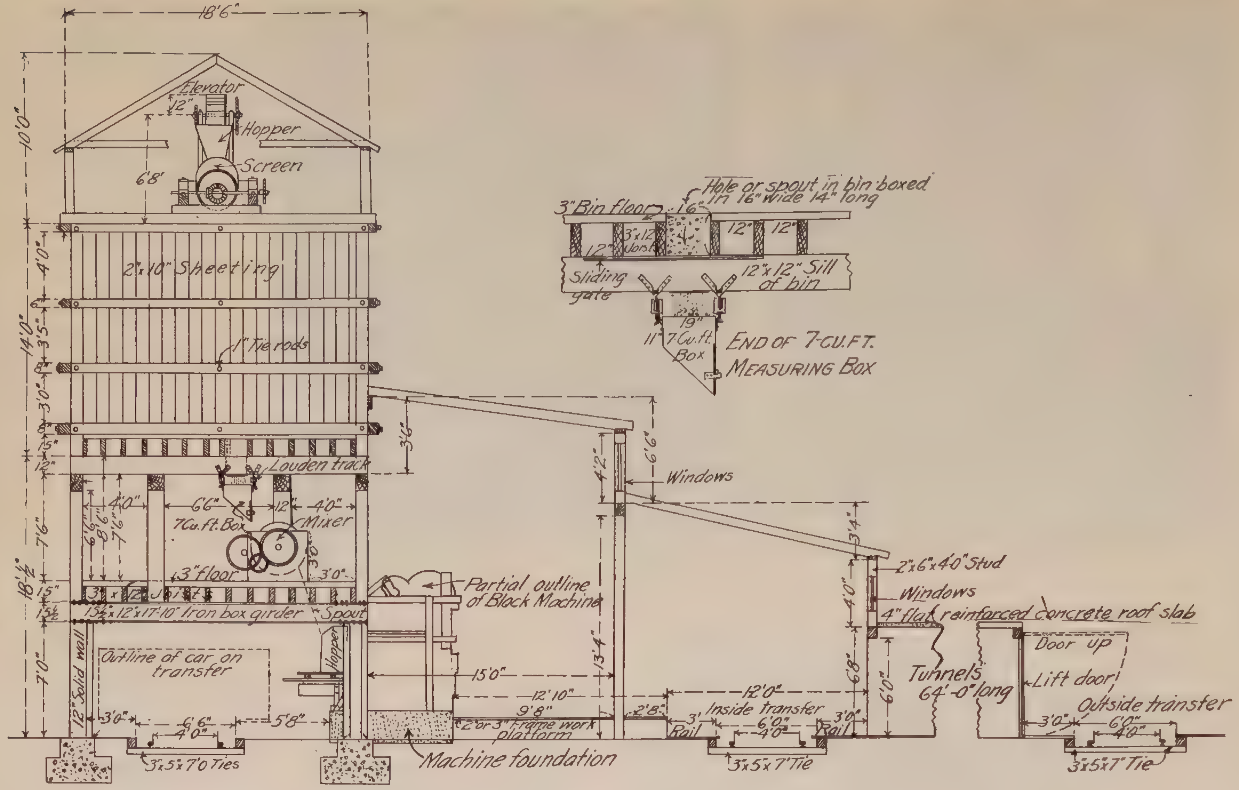

FIG. 7—VERTICAL LONGITUDINAL SECTION THROUGH KRIER PLANT

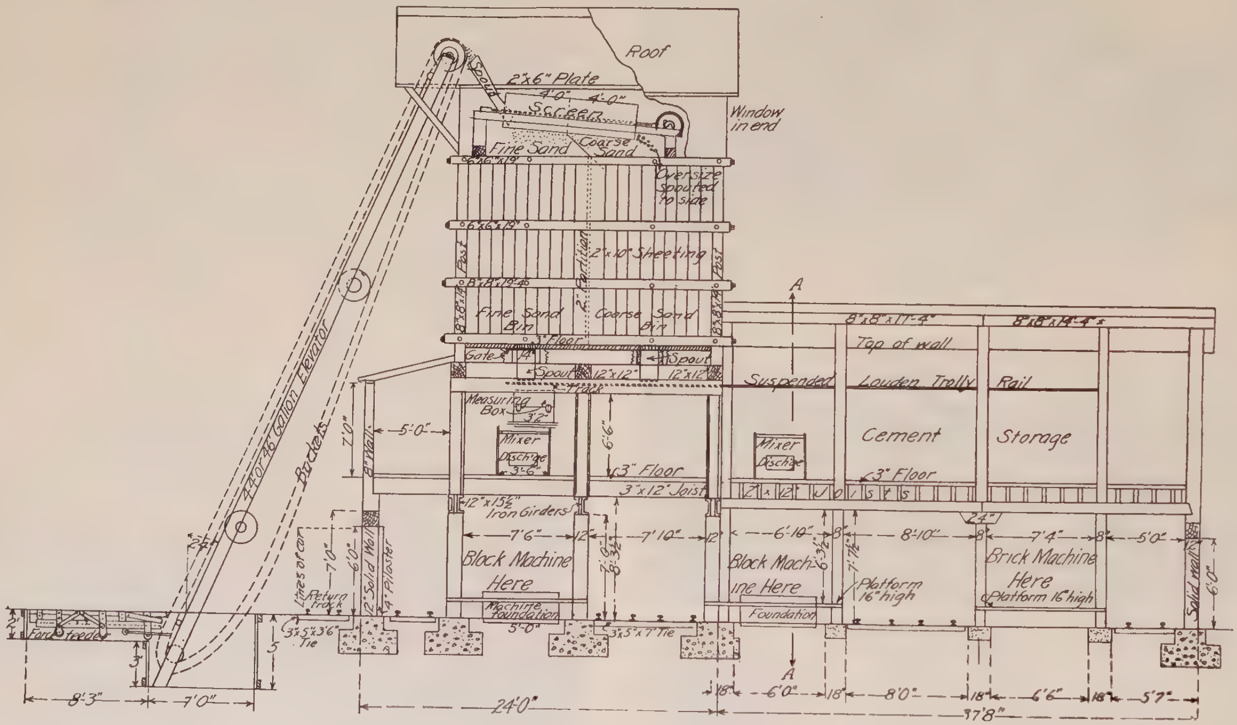

FIG. 8—VERTICAL LONGITUDINAL SECTION THROUGH PLANT SHOWING FORCED-FEED, ELEVATOR, SCREEN, BINS AND MACHINE LOCATIONS

As will be noted in Fig. 3, the mixers are on a mezzanine floor directly over the machine hoppers. The mixers are self-dumping and require only the throw of a lever to discharge the contents. The machine hoppers are built up so as to permit the discharge of the full contents of the mixer before the machine hopper runs low in concrete, thereby avoiding delays, and what is more important still giving the greatest possible mixing time. We get a full five to six minutes mix on every batch. That is where oversize mixers and large hoppers count.

Cement is stored on the mezzanine floor; capacity, sufficient for several carloads. Cement is brought in through a door in the rear of building, permitting unloading direct from trucks.

As will be noted from Figs. 1 and 3, a complete circulating system of cars is provided. When block are unloaded in the yard, the pallets are put back on

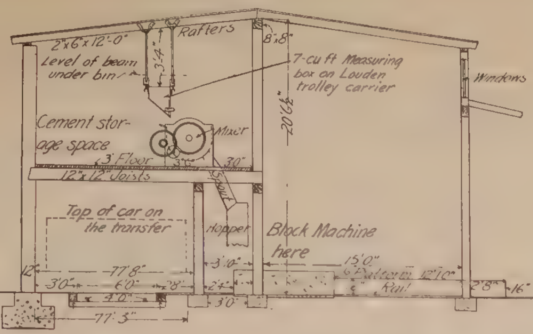

Fig. 9—Vertical Section Thorugh Plant Showing Balcony for Cement Storage, Mixers and Trolley Sand Box

the car, and the car is then run back on the right hand side of the machine. All the machine operator has to do is take the pallet off the car and place it in the machine. There is no double and treble handling of pallets. The empty car is transferred in the rear of the machine over to the left hand side. The long loading track admits a line of empties. As a car is loaded it is pushed forward and an empty is there to take its place. There is no congestion, no waiting for cars, no time lost in shifting racks or decks.

We use a special car, designed by the Besser Sales Co. with hinged decks, 10 ft. 4 in. long, which holds 120 block (8x8x16 in.) and so far as we know is the largest car in the industry. The cars are loaded from one side, obviating walking around the cars. The decks are hinged and cross slatted. The off-bearer simply pushes the pallet with green block along the channel instead of having to stand on or walk around the car.

The results are to be found in this, a machine operator and off-bearer handle 1,650 block in 9 hours or counting the two machines, we are turning out daily 3,300 to 3,400 block. It must be remembered that the solid 12-in. block are more than the equivalent of two 8-in. hollow block.

We use the same mixer for facing material as for rough concrete, as due to oversize capacity we have ample mixing time. A spout carries the facing material to a small box. This box is kept by the operator, who spreads the facing on the pallet, while the machine is making a block, so that faced block are made as rapidly as rough block.

One car man handles cars to the machines, takes empties in from the yard and delivers loaded cars to the kilns. It will be noted from the plan that return tracks for empties are on each side of the building so that with transfers in front and behind the machines it is impossible to have congestion.

We believe in efficient steaming of the blocks. We have found it pays. We have kiln capacity for 78 cars, or 9360, 8x8x16-in. block, so that we can cure block 48 hours if necessary. We have provided tunnels sufficient for three machines and have sufficient working space for them without alteration or change.

Fig. 4 shows a view of plant and yard. The manner in which light is thrown into the building is well shown. Even on dark days interior lighting is ample without artificial light. The best evidence is in the interior views from photographs taken by natural light. Ample ventilation is given with windows on four sides.

Fig. 5 shows a rear view of the plant from a point opposite that at which Fig. 4 was made. It will be noted that we resort to double piling for economy in loading onto trucks and for increasing yard storage (Fig. 6). For this purpose we use a power driven portable belt conveyor,[6] provided with rubber cleats. This conveyor is placed alongside loaded block cars, which are unloaded directly onto belts. We load block as high as 30 tiers. We use Mathews gravity conveyors[7] to load from storage piles onto trucks.

Figs. 7, 8 and 9 show sectional details of the plant.

We know we have an efficient plant, one that operates with a minimum of supervision and labor. We have had maximum production from the day we started the plant. We have realized the benefit of modernizing our business in the volume of advance orders we have booked since we started. We know we are making better block than before and at a lower cost. We have the satisfaction of knowing that we are turning out a block that will force competition to meet our standards.

We believe the concrete products business, with adequate production machinery, is a very desirable business for a building supply dealer. We know it helps him to sell more material. We are firm believers in the future of the concrete products business. It is a logical business for a building supply dealer. Lower building costs must be of interest to anyone who expects continuously to distribute building materials. Concrete masonry units are the only logical successors to wood and clay. When a concrete masonry house can be built for but very little more than the cost of perishable frame structures, a man must indeed be blind to opportunity who does not recognize the field for concrete masonry products. Faith backed by deeds counts in business as in religion, and our faith in the future of the industry is best demonstrated by the substantial investment we are proud of having made in the concrete block business.

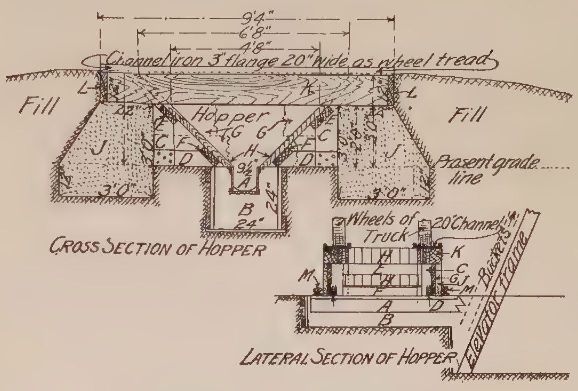

Fig. 10—Elevator Hopper Construction

A = Galion Force-Feed Device.
B = Trench 24" Wide and Deep for Feeder
C = 8"x8" Corner Posts 2' High—Beveled 45° at Top and Morticed at Base for Sill D
D = 4"x6" Sill 2' Long Beveled 45° and Morticed into Post C and Spiked to C and Flush with It.
E = 2"x8" x 6' 6" Long Spiked to Post C.
F = 2"x8" x 6' 6" Long Spiked to Sills D.
G = 2"x12" x 6' 0" Long Spiked to Sills D, to Post C, and to Hoppers H, as Ends of the Hopper
H = 2" x 10" x 4' 4" Sloping Sides of Hopper OR Use Tongued and Grooved Hard Wood. (Extending to Top Between Girders).
J = Concrete Buttresses to Carry the Girder-Runway K over the Top of the Hopper
K = 12" x 18" Timber Girder over Hopper (12" x 12" to Which are heavily Spiked 3 Pcs. of 2"x12"—9' long.) On Top of the Girder is Spiked a 3"x20"—in Channel as a Runway for the Truck Wheels.
L = 2" x 12" x 6' 10" Spiked to Ends of the Girders as Cross-Stays.
M = Ry. Rails Across Feeder Trench to Carry the Feeder

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[6] Portable Machinery Co., Passaic, N. J.

[7] Mathews Gravity Carrier Co., Elwood City, Pa.

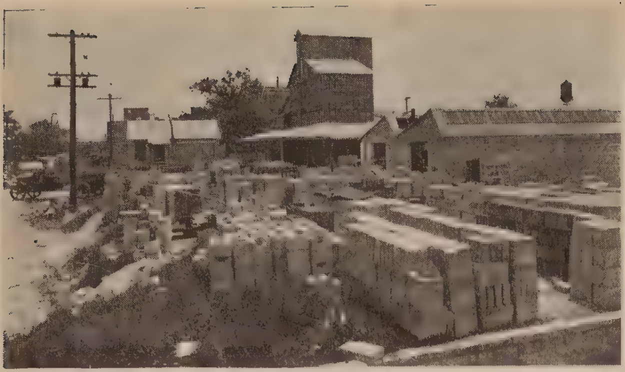

FIG. 1—PLANT OF CONCRETE PRODUCTS CO., HOUSTON, TEXAS

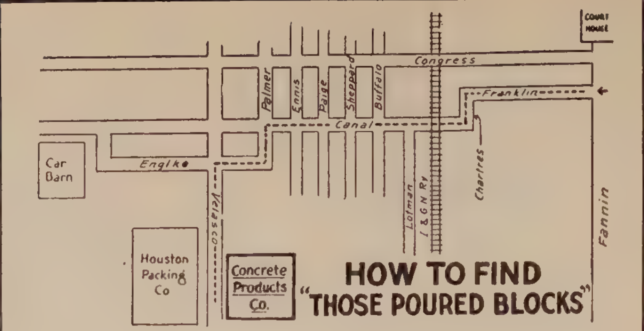

FIG. 2—THE PLANT OF THE CONCRETE PRODUCTS CO. IS NOT EASILY FOUND WITHOUT INSTRUCTIONS. THIS CHART ON THE BACK OF EACH BUSINESS CARD MAKES IT EASY

Saying It With Concrete

BY GRADY TRIPLETT
HOUSTON, TEXAS

Where there is construction there is an opportunity for selling some concrete products. While that is not the slogan of the Concrete Products Co., of Houston, Texas, it is an impression gained after a study of the manufacturing and sales methods of the concern. Its products run the line of building stone requirements from foundation blocks to trim stone for exterior work and mantel pieces for interior use. The field of selling is as broad as the use of stone in construction.

In developing the business of his concern, F. B. Weeks, president and owner, has progressed by establishing one product on a firm market and then adding other lines. His first product 10 years ago was a poured block. The poured block is still the major part of the business. While the outlet for it is kept open, the major sales effort is now turned toward the establishment of as wide a use of cast stone for building purposes.

The company has the patent rights on the Zagelmeyer process of concrete stone making for the Houston trade territory. The plant is equipped to turn out these block at the rate of 800 a day. The plant is equipped with a narrow-gauge rail system, which permits the hauling of work into the open for curing by weather or for running into the steam rooms for quick curing.

Only crushed granite faced block are made. Specifications never vary on block, the company declining to consider work when the buyer prefers block of different materials.

By holding to specifications and by pushing the sale, the poured block has been established as a building material with scores of Houston contractors, and is carried in stock by lumber concerns. The greater use is for foundation work and columns, but many homes and buildings have been built entirely of poured block.

Introduction of the concrete block for building purposes required overcoming a prejudice against the product in South Texas. Excessive periods of rain had established the belief that no concrete block would withstand moisture. While this opinion was the result of using block not properly made, it placed a wall of sales resistance before the Concrete Products Co. when it offered its block.

One means of overcoming this was the use of a demonstration at the plant. A glass container was made and fastened against a block, the union being waterproof. This was poured full of water and left standing, the volume of the water standing against the block. By this it was shown that the block would resist moisture for as long as it required the water to evaporate from the container.

Use of the block for building purposes finally brought the concern into the construction business. It still maintains what is almost a service in erecting its stone products. Where a general contractor adopts concrete stone for a building, the Concrete Products Co. will furnish the stone, leaving the contractor to do the work, and it will take a sub-contract, furnishing the stone and laying it.

There have been instances in which the whole contract for a building was taken, the lumber work being let to a sub-contractor.

Sale of the concrete block is largely through lumber concerns. The bulk of this business now comes by telephone, lumber yards ordering for their requirements just as they order shingles. Scores of contractors are users of the block, ordering for each building, as they order other materials from the lumber dealer.

When the value of the poured block had been established to the point that orders from lumber dealers and contractors assured sales of volume, the trim stone plant was added.

This brought another problem of selling. Instead of going out to overcome a prejudice, the trim stone had to be sold in competition with natural stone in both utility and in appearance. Now, instead of centering on the lumber dealer and the contractor, the trim stone is carried to the home builder and the architect.

The Concrete Products Co. is now completing the stone work on a new court house for Polk County, Texas. In that case, county officials had to be sold on concrete cast stone. Then the architect had to be sold. With the contract assured, the contractor had to be met. This resulted in the Concrete Products Co. being given the whole of the stone work on the court house job.

Taking the designs of the architect, molds were made at the Houston plant, where the stone was turned out. Then it was shipped to the job, where it was placed by workmen under the direction of a representative of the company. Even the floors are concrete tiling. These were cast in Houston, shipped as unfinished concrete and finished when laid.

The trim concrete stone mantel is a winning product with the Houston concern. For the fine homes being built in the city, special designs are made, often being taken direct to the home builder for sale. Some of the concerns engaged in home building and selling also use these products. Such concerns also buy foundation stone, columns and steps.

Steps are another specialty with the company.

These are manufactured in flights and sold either as a product or installed. Designs of an architect are followed, or designs prepared by the company are kept ready for sale.

Urns and basins for yards are kept in stock. While the sale of these is limited, these products serve to establish further the reputation of the concern for turning out special concrete products.

The Concrete Products Co. was started by F. B. Weeks and L. L. Reber. It was strictly a block plant, and the capacity was small. By the time of the period of deflation after the world war, its business had grown to the point that it was one of the two such concerns in Houston to survive the period.

Mr. Weeks is now president and secretary of the concern, holding all the stock, except that necessary for incorporation purposes. S. A. Long, as vice president and general manager, has charge of sales. Right now he is pushing the cast stone end of the business.

Concrete Specialties Company Tops List

By A. J. R. Curtis

Two years ago the Concrete Specialties Co., manufacturers of Straub Cinder Concrete block at Camden, N. J., jumped into the millionaire class by producing over 1,000,000 concrete block. L. A. Goodwin, general manager of the company, acquired wide fame with his stock pile of 75,000 units, which made it possible for him to negotiate an "immediate delivery" order for some 76,000. Last year the company added further to its fame by acquiring a stock pile which numbered 278,000 block on the last day of March. This was probably the largest stock of block ever assembled.

All records for stocks in the concrete block industry are unquestionably smashed, however, by the stock on hand in the company's yards, 505,792 units on March 8, 1924 (equivalent to 541,673 8 x 8 x 16-in. block. Approximately 10,800 bbls. of portland cement were required for the manufacture of this stock, which represents the surplus production over demand during the last four months.

It has been computed that there are block enough in the Concrete Specialties Co.'s stock to build the walls of about 275 small residences, or the foundations for about 900 dwellings of ordinary size.

The Hide and Leather Building, newly constructed of reinforced concrete, at New York, standing 18 stories high on a base 70 x 80 ft. required 9,600 bbls. of cement, and may be used to indicate the relative importance of the Camden stock pile.

It is now a matter of established policy with the Concrete Specialties Co. to carry adequate stocks, just as it should be in every progressive concrete products factory. While good judgment counsels careful restriction of stocks of specials, in order to avoid the accumulation of dead material, a staple commodity, such as ordinary full-sized block, may be safely, and should be, carried in ample quantity. Material prices are frequently cheaper in winter and labor usually more plentiful and contented although no more—sometimes less—expensive.

The common sense of carrying adequate stock piles has been well demonstrated by this company, to which most concrete products manufacturers should feel indebted for the setting of a good example.

Concrete Products in 20 Years

By Robert F. Havlik

From an address presented as part of Symposium on Progress of Concrete Construction in 20 years at 20th Annual Convention, Chicago, February 27, 1924. —By courtesy in advance of copyrighted *Proceedings*, Vol. 20, American Concrete Institute.

Probably the first concrete product made was the concrete building block. Precast concrete block were made as far back as the middle of the nineteenth century, but did not come into common use until the beginning of the present century, when many ingenious men conceived the idea of making hollow building block. While some were inventing machines for making hollow concrete building block, others devised ways and means of manufacturing other concrete products, such as drain tile, sewer pipe, floor tile, and roofing tile. Machines for such products were first placed on the market between the years 1900 and 1907. The development since the early part of this century has consisted in converting hand machinery into automatic machinery, so as to reduce labor cost to a minimum. The principal reason concrete building blocks were not popular prior to this century was that the early block were all made solid. The invention of machinery for making hollow building block put the industry on a competing basis with other building materials.

The most common form of hollow building block is the one with three cross webs and two air spaces. A one-time popular form was one with two rows of staggered air spaces. Other popular forms of block are the so-called "two-piece" block. Some of these are tied together with metal ties, the ties being inserted in the block during manufacture. Others are laid up with connecting metal ties, and still another form of block is the interlocking "T" shaped two-piece block. All these, excepting the staggered air space block seldom seen now, have been very popular to the present day.

Many and interesting have been the arguments in favor of each particular type of block. Good high grade walls can be built with each of the many types of block now on the market, provided the contractors using the products, and the manufacturers making them, put out a high grade job. In the first place, good concrete block cannot be made unless the manufacturer is honest enough to put in the requisite amount of cement. In addition to this, he must have a sufficient knowledge of the concrete industry that will enable him to use a sufficient amount of water in his concrete. Finally, if he will put the necessary expense into manufacturing the product, he will produce units with beautiful textures that will satisfy the most exacting.

Most building block made in the past have been made in rock face designs, in imitation of pitched stone. This custom retarded the industry for many years, and has done more harm to it than any other one factor. In recent years, however, there has been a decided tendency to make plain block with granite facings. Rock face block have been used principally for foundations under frame buildings, and will doubtless continue in favor for this purpose for a long time to come, but for high grade construction, plain block with textured facings are usually used. Trim stone made of the same textures has become very popular, so the faced block are bound to benefit greatly thereby, as the two can be used to excellent advantage in combination.

Hollow concrete building block are usually made in 16-in. and 24-in. lengths, and for walls 6, 8, 10, and 12 in. thick. Thicker walls are produced by using various combinations of these block. The most common size of building block is 8 x 8 x 16 in., which can usually be found in the foundations of two-story residences, and in small cities for the walls of two-story residences, including basement walls. In most localities concrete block walls for foundations and inexpensive buildings are cheaper than brick walls. This, of course, holds true only of the common concrete block. High grade faced block are more expensive than common brick, but will compete with the corresponding good grade of face clay brick backed up with common brick.

Some conception of the tremendous quantity of concrete building block being used at this time can be had from the following statistics, for which I am indebted to the Portland Cement Association:

In the year 1921 the equivalent of 175,000,000 8 x 8 x 16-in. concrete block were made in the concrete products plants that have made annual reports to the Association. Considering the fact that a large percentage of manufacturers failed to send in these reports, it is fair to assume that the actual number of block turned out by all the concrete products manufacturers greatly exceeded this figure. This number of units was increased to 300,000,000 in 1922, and 350,000,000 in the year 1923. The 1923 production required the enormous quantity of 7,000,000 bbls. of cement. It is of interest to know that most of these block were produced in the Central and Eastern States. With the coming years, the industry is bound to spread throughout the south and west, so that the consumption will double, or perhaps even treble, in a short time. This will be brought about more rapidly by constant advertising of high grade building blocks made with facings in which the aggregate has been exposed by scrubbing, acid treatment, or some other method.

A big field that has been overlooked by most manufacturers is that of Ashlar veneer in competition with face brick or cut stone. High grade white cement granite veneer building block 4 in. thick, or less, can be sold at a big profit at one-third to one-half the price of cut stone, and the profit to the manufacturer will be many fold that made on ordinary concrete building block. They find favor with architects, and if worked in combination with concrete trim stone, will prove a source of big profit to the manufacturers, and at the same time such units will effect a big saving to the owners of the buildings in which they are used.

There is no doubt that white-face textured building units, whether they be in block size or trim stone size, are superior to any other type of masonry material, excepting natural granite. (Unless it is a concrete unit which is of the same quality throughout.—Editor.) They are far superior to Bedford stone, in that they do not soil readily and can be cleaned with muriatic acid and water at a slight cost, whereas most natural stone can only be cleaned satisfactorily with a sand blast at considerable expense.

Concrete trim stone is extremely popular at this time. I can well remember how difficult it was 10 or 15 years ago to obtain even an audience with the average architect in behalf of concrete trim stone. Today it is a common practice to ask for alternate bids on concrete trim stone in competition with natural stone and terra cotta.

In recent years another building unit, known as the "light weight" building tile, has been developed, and this is meeting with considerable favor. No less than 10,000,000 of these units were made in the year 1922, and over 20,000,000 were made in the year 1923. While this is a small figure as compared with concrete building block, it must be remembered that these units have only been on the market for a few years, whereas the hollow building block have been on the market for a quarter century. In view of this, it can readily be seen that light weight concrete building tile are destined to play an important part in the building industry of this country.

Concrete brick have had a varied history. It has been a very difficult matter to produce concrete brick at a profit to the manufacturer in competition with common clay brick. In sections of the country where clay brick are scarce, concrete brick can be produced profitably, but in sections where clay brick are more common, it is difficult to make concrete brick profitably excepting with high grade automatic machinery. In the matter of face brick, however, the situation is entirely different; such brick can be sold profitably in competition with a moderately priced face clay brick. In some districts, white cement granite brick are becoming popular. The reports from such concrete brick plants as made a report for the year 1923 to the Portland Cement Association show a production for one year of over 150,000,000. The cement required for these amounts to 300,000 bbls. The concrete building tile produced in 1923 consumed 200,000 bbls.

Concrete roofing tile have not made as big strides as concrete building block, tile, and brick, but in the last few years there has been a decided improvement in the situation. There are over fifty high grade producers of concrete roofing tile in this country, making over 80,000 squares of roofing tile annually, valued at about $1,000,000. Most of the concrete roofing tile made years ago was not as strong as clay tile, and this retarded the industry, but that which is now being produced is a superior quality that closely resembles the clay product, both in appearance and strength, and sells at about 60% of the price of clay products.

Concrete drain tile, sewer and water pipe are becoming more popular from year to year. In fact, the increased popularity of these products is almost beyond comprehension. While concrete pipe has been generally used in this and foreign countries for over eighty years, the greatest progress has been made in this century, and most of it probably in the last decade. Concrete drain tile and sewer pipe are more uniform in quality than clay products, and, on the average, stronger, and usually they are also cheaper, even in the clay districts. Sewer pipe are manufactured in two classes—plain and reinforced. The plain pipe is produced in standard sizes from 4 in. to 24 in., and the reinforced pipe in sizes from 24 in. to 108 in. internal diameter. One company alone has sold over five hundred miles of reinforced concrete pipe for sewer construction. Reinforced concrete pipe are also used for culverts in sizes from 12 in. to 14 in. Such use has become a standard practice by the principal railroads and nearly all of the state highway departments. In 1923 such pipe was placed on an equal basis with cast-iron pipe, as to permanent strength and economy, by a committee of the American Bridge and Building Association. Reinforced pipe is also being used extensively for irrigation work and water supply systems. The State of California at Delhi alone has installed an irrigation system of over two hundred miles of pipe from 12 in. to 36 in. internal diameter. Concrete pressure pipe for water supply system is being used quite extensively. One of the largest installations on record is at Tulsa, Oklahoma, consisting of fifty-two and a half miles of 54-in. and 60-in. pipe. Concrete drain tile have been used principally in the Middle West, in standard sizes ranging from 4 in. to 72 in. internal diameter. One of the largest jobs on record was awarded in 1923 in Minnesota, consisting of four hundred thirty-six miles of tile 25 in. to 34 in. internal diameter. 70% of this mileage was concrete, embracing principally the larger diameters.

I have endeavored to touch upon the most interesting and important features of the concrete products industry. The markets of the country have just been touched, and the use of these products can be increased tremendously. As a whole, I believe the concrete products industry has not used as high grade salesmanship in advancing its interests as have other competing products. There is a bright future for the industry as a whole in all its various branches if as good a brand of salesmanship is used in selling these to the public as our competitors use. High grade concrete trim stone and building block of textured surface with exposed aggregates have a most promising future.

Building Codes and Building Units

All those connected in any way with the products industry are familiar, in varying degrees, with the need of suitable ordinances affecting concrete masonry units. This is gone into thoroughly in William F. Lockhardt's paper before the American Concrete Institute, mentioned only briefly in the March issue. Some existing ordinances are worse than none at all, at least when considered from the fact that it is easier to obtain the adoption of a good ordinance where none has before existed than to get rid of bad features in an existing one.

Certain building code provisions that hamper and restrict the manufacture and use of concrete masonry units bob up with such persistence and uniformity of language as to leave little room for doubt that they have merely been copied from one code into another, without any thought of the harm or injustice that might be caused.

Among these objectionable building code provisions may be mentioned the one requiring the date of manufacture to be stamped or marked on every unit. This one appears quite frequently. It is a practice as ineffective and as useless as marking eggs with the date they were laid. The eggs you buy are no fresher because of the marking. Another very common restriction is the one regarding maximum air space, usually specified at 33%. Some one started this idea, and others followed without asking why. If the unit is strong enough to meet the specified ultimate crushing strength, considered over the gross area, no one should care what the air space is. Another bad feature is that requiring hollow block used in foundation walls to be filled with concrete. The only visible effect produced by this provision is that it makes the building cost more. If the foundation wall is in a low and undrained location, it should be waterproofed with an exterior coat of cement plaster or some special waterproofing compound. If the location is well drained, such a coat of waterproofing may not be necessary. But, in any event, the mere filling of hollow spaces would not prevent, in undrained locations, the seepage of water through improperly made mortar joints. A few cities, Chicago among them, actually *prohibit* the use of hollow block in foundation walls! Other objectionable features that often appear in codes are the limitation on the use of hollow block to certain classes of occupancy, such as dwellings and small apartments, and the restriction to certain height limits, such as 40 ft. It is obvious that any building material that will stand up in the comparatively thin walls of dwellings or small apartments will also stand up in the thicker and more stable walls of warehouses. The frequent repetition of restrictions of this sort is sufficient proof that they were merely copied and that little or no thought has been given to the reasons for them.

At the same time, can an overworked and underpaid building inspector of a small or medium-sized city be censured for copying from other codes, when in addition to his numerous regular duties, he is told to revise or rewrite his building code? Would it not be good for him and for the products industry if he were furnished in the beginning with a suitable ordinance, one which he could use as a guide, actually in force in some city? If he were furnished at the same time with an analysis of that model ordinance, in which the various sections were explained, he would have a firm working basis to start from. That is precisely the purpose and intent of the paper presented to the American Concrete Institute. It will get the writer of a block ordinance started off on the right foot.

The first part of the paper deals with the need for suitable ordinances regulating the manufacture and use of concrete masonry units, so that the industry shall neither be hampered with unnecessary restrictions nor strangled through the activities of inexperienced or unscrupulous block makers of the back-yard variety.

Part 2 is a critical analysis of the block ordinance adopted by Camden, N. J. in September, 1922. While the Camden ordinance is not perfect, it is nevertheless quite satisfactory. The products industry would be fortunate if every city and town had one like it. The various sections of the ordinance are taken one or two at a time and commented upon. In these comments reasons are given for the various provisions, and where criticism is considered necessary it is of a constructive nature.

If placed into the hands of a building inspector or a building code committee charged with the preparation of a block ordinance, this paper should have the effect of producing a finished ordinance fairly acceptable to the industry. On the other hand, if the person or persons responsible for writing the ordinance have already drafted an ordinance taken from various sources and including a number of the objectionable features previously mentioned, it is often very difficult to induce them to switch over to something that is satisfactory.

The Editors will welcome authentic information about interesting concrete engineering jobs.

Houston Woman Success as Concrete Contractor

There are two of the Arnolds in the concrete contracting business in Houston, Texas, F. L. Arnold and Mabel L. Arnold, husband and wife. Mrs. Arnold attends to all the details of the contract work, while her husband attends to completing the contracts, once they are made.

All the business transactions are handled by Mrs. Arnold, who may not know the art of finishing concrete as her husband does, but she has learned in two years enough of the business of making contracts for concrete construction to place her at the top of her business in Houston.

Mrs. Arnold has a formula for success as a contractor that is so brief and simple that it seems almost trite. But she is authority for the statement that it will bring success. Here it is.

First: Never enter a bid when the contract is going to be let at the lowest figure. Second: Bid on definite specification and service. Third: Make all work equal to the specification. Fourth: Keep that up.

That was the schedule on which she started two years ago. It has been followed since. The only difference between the present and the start is that she enters very few bids now. Most of her work comes from general contractors, who give her instructions to do certain work. It is done, and the estimate is made after the work is completed.

"They did seem a bit surprised at first," Mrs. Arnold admitted, when asked how her first efforts as soliciting were taken. "But they soon saw that I was in earnest. After a few jobs had been completed, they gave full confidence. For I make few bids now. Most of the work comes from contractors, who know their work will be done according to specification, and that the charge will be made according to time and material used."

In the first 20 months of their venture in contracting, the two Arnolds laid more than 500,000 sq. ft. of concrete flat work. That does not include curb and gutters. Mrs. Arnold has attended to all the business details of that volume of business. She has made the estimates, prepared the payrolls, done all bookkeeping, kept track of all materials bought and found time to keep her home running and have the companionship of two sons.

"Estimating was the hard part," she said, "since I knew nothing about cement work. But my husband helped when I was in doubt. In fact, he is responsible——"

That statement was never finished, for the husband quit his work long enough to contradict, "She was the one who thought we could get ahead faster if we got into the contracting end of the business."

"No, you thought I could attend to the soliciting and estimating," she rejoined.

That is a question perhaps never to be settled. Meanwhile, Mabel L. Arnold is still attending to the soliciting and estimating, while her husband, whose name is never signed to checks and estimates, sees to the laying and finishing of the work.

There is something determined in the career of the woman contractor, both before and after her essay into the contracting field. She was left a widow, with two sons, when her first husband, Harry McCormick, Wharton county deputy sheriff, was killed in attempting to arrest a negro. After that she came to Houston and entered a business college.

Her record of completing the bookkeeping course in 38 days still stands at that business college. She had completed her course and was employed to keep the books of an automobile concern, when she was married to F. L. Arnold, who was then a cement finisher.

Some time after that, the proposition of going into the contracting end of the business came up for consideration. Whether she became a bonded concrete contractor because he believed she could do it, or whether she started the work on her own initiative are questions the Arnolds themselves are not agreed on.

In February, 1922, the first work was done under her name. She owned then four wheelbarrows and a mixing board. Since then the list of equipment has increased until a second mixer has been bought, a truck, a tool car and a light business car are among the assets. Twenty-four men are employed.

Mrs. Arnold says she finds it profitable to confine her dealings to those with general contractors, who appreciate quality work. She prefers to have these business dealings put on the level of doing the work without the necessity of bidding. When she prepares a bid, she is hoping for the time when the work of the contract will be given her without a bid.

"That's the reason I refuse to enter a bid when the contract is going to be let on price," she said. "Contracts of that sort have to be made, of course, but I do not care to do work as cheap as it can be done. I want it done as well as possible.

"Contractors appreciate that, for our business is growing every month, and those for whom we have done the most work are our best boosters."

CONCRETE wants information as to Successes in concrete contracting and products manufacture—information as to the how, why and *who* of the Success.

Reinforced Concrete Bridges

A. E. Lindau

Presented as part of Symposium on Progress of Concrete Construction in 20 years at 20th Annual Convention, Chicago, February 27, 1924.—By courtesy in advance of copyrighted *Proceedings*, Vol. 20, American Concrete Institute.

The new world opened to the architect and builder of buildings by the development of concrete and reinforced concrete was likewise opened to the engineer and the builder of bridges. The vision of the bridge engineer as well as the architect was stirred by the vast possibilities of a building material which is commonplace today but was practically unknown a generation ago. For thousands of years we have built bridges of stone, brick, timber, and, in the last century, also of iron and steel. In the short span of a single generation, however, a new material has been developed, and its use has been extended throughout the civilized world.

Bridge building is an ancient art. The Chinese are credited with building masonry arches as early as 2000 B.C. In fact, records seem to indicate that the Chinese used both slab and arch construction in their bridge building, and are entitled to rank with the ancient Assyrians as bridge builders.

In Persia, over the River Diz, we can see today an arch bridge consisting of a series of 20-ft. spans, 1200 to 1300 ft. long, still in a fair state of preservation, and said to date about 350 B.C. The ancient Greeks built a bridge at Assos, of stone slabs doweled together, and supported by diamond-shaped piers spaced about 10 ft. apart; the stone slabs were 20 in. thick and 24 in. wide. This structure is a prototype of our present-day concrete slab bridges, especially of the precast type.

To the old Romans, however, belongs the glory of having carried the art of bridge building to a greater degree of perfection than any of the older civilizations. In fact, we owe to them not only examples of marvelous masonry construction and the development of the arch bridge to a degree scarcely excelled today, but also the discovery of the use of cement and the making of concrete. There are, in fact, grounds for believing that they realized the advantage of reinforcing their concrete structures. In the foundation of one of their temples, bronze rods were found embedded in the concrete, leading us to believe that, in a rudimentary manner, at least, the Romans anticipated our modern reinforced concrete construction by about 2000 years.

To complete our picture of the state of the art of bridge building handed down to us by these master-builders, let us stop for a moment and note the magnitude of some of their largest undertakings:

The bridges Marcia built in 145 B.C., 61 miles long with 12 miles of arch construction; Claudia, 50 A.D., 46 miles total length and 10 miles of this in arch construction; Anio Novis, 52 A.D., 58 miles total and 9 miles of arches; Alexandrina, 226 A.D., 15 miles total length, 7 miles of arches. In all, according to a summary by Professor M. A. Howe, a total of 63 miles of arch construction was built between 312 B.C. and 226 A.D., a truly astonishing achievement and a testimonial of the degree of skill attained by those old engineers. It is not alone their skill in construction that challenges our admiration, but the ability to combine architectural beauty with engineering proficiency that marks their work as extraordinary.

In the barest outline the foregoing represents our heritage from our early ancestors. The art of masonry construction, as applied to bridges, can almost be said to have reached its high-water mark at the hands of the Romans, and for 1700 years no appreciable advance was made. As the light of civilization flickered and was almost extinguished during the Dark Ages, we can barely trace the story of concrete. Here and there an occasional example may be found, as in the case of a foot bridge at Amalfi, on the Gulf of Salerno, built by the Moors in the 6th century. However, we can pick up the thread of the story again a century ago in the construction of a large concrete bridge over the Derdogne, at Souillac, France, built in 1816, in which Roman or Pozzuolan cement was used. But the examples are few and far between until we reach the period in which portland cement was discovered and manufactured.

This was an epoch-making discovery in the field of bridge engineering as well as in architecture.

The next great step in the development of the art was the invention of reinforced concrete. Whether a rediscovery of methods known to the Romans or not, the incorporation of steel bars or fabric in concrete opened a new era to the bridge engineer. Up to this time, he was bound by the traditions and limitations of masonry construction. It is true that plain concrete offered enormous advantages in many directions over the older art of the stone mason; yet it was, after all, artificial stone and subject to the same limitations in design. The combination of the two materials, steel and concrete, produced a new material, and marked a radical departure from old forms and methods. No longer was the designer bound by the conventional methods of arch construction. The strength imparted to the concrete by the reinforcement so materially decreased the weight of the structure itself as to make it possible to erect arch bridges of astonishing length of span and beauty of form. Not only that, but girder bridges and even trusses are added to the list of types available to the designer.

The credit of first designing a reinforced concrete bridge may always remain a matter of controversy. Thaddeus Hyatt, an American, and Francois Coignet, in France, were early workers and experimenters in the field of reinforced concrete, and both understood the value of reinforcment. Joseph Monier, however, in a supplementary patent, dated August, 1873, made specific claims for the use of his system of construction to building of arch bridges, and illustrates by diagram in his patent applications his ideas of reinforcing such structures. Monier's ideas seem a little crude and immature to us now, but they embrace the broad principles on which we have reared the art as we know it today. The original Monier system employed wire netting near the intrados (or lower face) of the arch only, but was later modified so as to use two systems of nettings—one near each face or surface of the arch ring. Many Monier arches were built in Europe, one of the earliest of which we have a record of being a foot bridge of 53-ft. span and 13 ft. wide, built in 1875.

Progress in the new method of construction, while a little halting to begin with, soon gained momentum, and we find that European engineers quickly gained confidence in reinforced concrete and reveled in the freedom gained by it. So we find an arch bridge, built in Switzerland in 1891, having three spans of 128 ft., in which the crown thickness is 6½ in. Again, we find a bridge, built in Germany in 1890, with a 132 ft. span and a crown thickness of 9.88 in. As Mr. Thacher remarks in his paper before the International Engineering Congress in St. Louis in 1904 (just 20 years ago), "Such delicate dimensions would not be seriously entertained in the United States." While this remark clearly brings out the difference in European and American practice of 20 years ago, the gap has been closed in recent years, and we can now show a multitude of examples as daring in design and "delicate in dimension" as those found abroad.

Under the favorable conditions of economic advantages and freedom of design, reinforced concrete arch design developed in various ways away from traditional forms of masonry construction. The first examples in Europe as well as in this country belong to the old Roman or medieval type; with arch ring the full width of the bridge, parapet walls rising from the arch ring to the level of the roadway, and a back fill of earth to form the foundation of the road-bed. For moderate spans this type is still in common use and has some advantages, viz., the back fill absorbs the shock of moving loads and tends to distribute these loads to a fairly uniform intensity over the surface of the arch, the back fill also costs less than a concrete floor system above the arch ring. In long spans, however, the weight of the back fill imposes so heavy a burden of dead load that it becomes desirable to carry the roadway on superstructures of some kind. This led to the open spandrel type.

Open Spandrel Arches

In this type the spandrel walls are omitted and the roadway is carried by a floor construction, which may be either of the beam and slab type or a series of small, or supplementary arches. Here we find the designer taking advantage of some of the possibilities of reinforced concrete, reducing the quantities of material and thereby the cost, and at the same time producing a structure more pleasing to the eye. Although the structure in general appearance may resemble somewhat the older arch bridges of the double-deck type, yet in detail it is a wide departure from previous forms. One of the earliest examples of this advance in design is represented by the three-span arch bridge over the Ybbs, near Weidhofen, built by G. A. Wayss & Co. in 1898, which has a main span of 147 ft. and a crown thickness of 15½ in. Quite an airy-looking structure, it must be admitted, and a remarkable one considering the date of construction.

An interesting modification is illustrated by the highway bridge over the Colorado river, at Austin, Texas. Here we find the open spandrel type bridge with cantilevered sidewalks, which yield a further economy by reducing the length of the supporting piers. This is a distinct departure from the masonry and even plain concrete types. In neither of these older designs is it practicable to reduce the pier length by projecting the superstructure materially beyond the faces of the piers.

Ribbed Arches

The genius of Hennebique in discovering the possibilities of reinforced concrete is indicated by his designs of ribbed arches. For short spans, the roadway slab is built integrally with the ribs, making the structures, in effect, a curved T-beam construction. In the longer spans, however, the dead load of the structure can be saved by separating the roadway slab from the ribs by means of supporting columns. One of the most notable examples of reinforced concrete bridges built in the early days is of this type. The bridge is located at Chatellerault, France, and built in 1899. At the time of its construction, it was the longest reinforced concrete arch span every attempted; the middle span is 164 ft. and the two side spans each 131 ft., each span having an arch ring stiffened with four parallel ribs. The roadway of reinforced concrete beam and slab construction is supported by columns which transmit this load to arch ring directly over the ribs. Here we still have the traditional arch ring, but the material in the ring has been distributed so as to stiffen or strengthen it along the lines of the applied load. The Chatellerault bridge stands out as a landmark in reinforced concrete bridge design. The dimensions of all its members were refined to such an extent that we may say we have a concrete structure which, in appearance, approaches a steel structure.

Isolated Ribbed Arches

The Chatellerault type has been modified by omitting the arch ring between the ribs. In other words, if it is of advantage to take a part of the material in the arch ring and make ribs of it, why not concentrate all of the arch ring material in the ribs? Under certain conditions of span and loading this advantage obtains, and as a result of this modification, we have arrived at the "last word" in reinforced concrete arch design. While examples of this most modern type may be found as early as 1906, it is only in the last few years that the design has become quite generally adopted, especially for long-span monumental structures. In fact, we have in the United States today a number of notable bridges of this type; as, for example, the Arroyo Seco bridge, near Los Angeles; the Washington Memorial, built by Newcastle County, Delaware, as a memorial to the soldiers and sailors of Delaware who had taken part in the wars of the nation; the Detroit suspension viaduct in Cleveland; the Francis Scott Key bridge over the Potomac; the Gilbert St. bridge in Danville, Ill.; and many others, in connection with which data is not available.

Melan Arches

A decided innovation in the matter of combining concrete and steel was introduced by Professor Joseph Melan, of Austria-Hungary, in 1892. The Melan arch consists of a concrete arch in which rolled steel beams or riveted lattice arch-ribs are embedded. For short spans, rolled I-beams are employed, and for the longer spans, the latticed ribs.

The first Melan arch bridge built in the United States was erected at Rock Rapids, Iowa, in 1894. Following this, in 1897, the Kansas River bridge, at Topeka, of five spans with a total length of 693 ft. In rapid succession these structures were followed by others, so that by 1904—in a period of ten years—about 300 spans were constructed throughout the United States under the Melan, Thacher, and Von Emperger patents.

Hinged Arches

One of the most startling innovations in reinforced concrete design is the introduction of hinges for arch bridges. Dr. Von Emperger, in a paper before the American Society of Civil Engineers in 1894, describes an arch bridge, at Wurtemberg, over the Danube which has a span of 164 ft. and a rise $\frac{1}{10}$ of the span, and is provided with three cast-iron hinges, one at the crown and one each at the abutments. The use of hinges seemed particularly applicable to Melan construction, and many interesting examples of this type of bridge can be found in Europe. American engineers, however, have not adopted this device to any great extent, although some hinged arches have been built here.

Railway Bridges

The railroad engineer approached concrete construction with due caution. The art was fairly well established before he felt justified in trusting the new material to the severe conditions he had to deal with. To the Illinois Central Railway apparently belongs the credit of being first in the field, as early as 1895 they built plain concrete arch culverts. We are also indebted to the Scotch[1] for pioneer work in this field. The West Highland Railway in 1898 built a number of plain concrete arches, varying in span from 30 to 50 ft. One bridge at Borodale, however, had a span of 127 ft. A few years later, American railway engineers became interested, so that by 1903 several railways systems had concrete bridge work under way. The D. L. &. W. built a twelve-span bridge at Newark, and the Illinois Central boldly extended the field of concrete construction by building in 1903 the Big Muddy arch bridge at Carbondale, Ill., having three spans of 140 ft. long in the clear. The Big Muddy design, considering time and conditions, was startlingly bold, but the traditional influence of masonry construction is in evidence in building the arch ring in sections or voussoirs, in every respect like a stone arch, and making no attempt to use reinforcement. Similar in character but of somewhat lighter proportions is the Big Four bridge at Danville, Ill.

In total length of structure, the Long Key viaduct of the Florida East Coast R. R. surpasses all modern bridges, and in this respect competes successfully with the old Roman viaducts. The bridge consists of a series of 50-ft. semicircular arch spans having an aggregate length of six miles. Of the notably long bridges may be mentioned also the Galveston Causeway. This structure provides for a double track railroad line, double track electric line, and a 19-ft. highway. It consists of a series of 70 ft. arches, and has a total length of 2455 ft.

Girder and Slab Bridges

The use of various forms of arch designs for bridges is, after all, largely a modification of earlier forms, and consequently did not call for either the technical skill or the courage in breaking "new ground" demanded by slab and girder design. This venture awaited the development of the mechanics of reinforced concrete beam action and the verification of the theory by tests. Hennebique reports that in 1893 he built his first girder bridge at Don, Department Du Nord Paris. Apparently this phase of the art developed rapidly, for we find a Hennebique girder bridge at Yverdon, with a span of 42 ft., built in 1896; at Lausanne, in 1896, a span of 49 ft., and in 1903 a span of 66 ft. One of the boldest of this type is a girder bridge, built at Milan in 1895 on the Walser Girard System, having a middle span of 84 ft. As an achievement in length of span, it is surpassed by few structures today.[2] Exact data on the introduction of this type of bridge in the United States is not available, although examples of flat-topped culverts for railroad work as early as 1899 can be found.

As knowledge and confidence in reinforced concrete grew, bar reinforcement was substituted for I-beams, so that by 1904 highway bridges as well as railroad culverts of reinforced concrete slab and beam design were quite extensively used for moderate spans. In fact, by 1907, many railroads in the Middle West had adopted reinforced concrete as standard construction for culverts and moderate slab spans. Of special interest is the track elevation work in Chicago by the Illinois Central and the C. M. & St. P. Ry., in which the roadbed is carried over street crossings on precast concrete slabs.

The invention of the flat slab or girderless floor for buildings has also been extended to bridges. A bridge in Colorado having a 38-ft. span is a notable example in the highway field, and in the railroad field we find the D. L. & W. has built a number of them where head room was at a premium.

Truss Construction

Realizing that in long-span girders the dead load of the girder itself will establish the economic limit of span, open web or truss designs have been attempted and in many cases successfully executed. Particularly is this true of what is known as the bowstring girder. This is really an inverted arch, in which the floor system is suspended by hangers from the inverted arch, and the thrust of the arch taken up by the bottom chord. The elimination of the thrust may at times make a very great saving in cost of supporting piers, as well as maintain the integrity of the structure in case of settlement of the foundations.

Summary

The ground so far covered by no means exhausts the variety of forms developed up to present time, but enough has been given to indicate the wide range of designs available to the engineer, the wonderful flexibility of the material and the intense development that has taken place. Unfortunately data are not available to show by figures the increase in volume of concrete and reinforced concrete bridge construction from time to time, but a hasty glance at the landmarks in the history of the art may serve to give us, in outline, a picture of the industry that has been built up. Keeping in mind that concrete was used by the Romans in their bridge work, that for seventeen centuries no advance was made, and that during this period only an occasional structure serves to connect the present with the past, we reach the early 19th century without any marked increase in activity. Then a few examples in the next 50 years following the invention of portland cement. By 1875 reinforced concrete had been invented, and the volume of construction experienced another sudden forward movement. At this time, concrete had been introduced in the United States by the building of a plain concrete arch in Prospect Park in Brooklyn in 1871. By 1889 the first *reinforced concrete* bridge was built in the United States at Golden Gate Park, San Francisco. We can now measure our progress in years instead of centuries and a widening application of the art throughout the world. By 1893, it is estimated that 300 concrete bridges had been built in Europe, in the ten-year period from 1894 to 1904 in the United States about

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[1] Since this paper was prepared it has come to the writer's attention that the Illinois Central Railroad was constructing arches and culverts of plain concrete as early as 1894, and that by 1896 it had become a settled policy of this railroad to erect concrete piers and abutments as well. Much of this early concrete is still in use and in an excellent state of preservation (A. E. L.).

[2] It may be of interest to note that recently a reinforced concrete girder bridge was built in Humboldt County, California, having a span of 142 feet.

100. During this same ten-year period, Hennebique and his agents built over 400 bridges, and it is probable that at least that many more were built by all the other engineers and concrete specialists devoting themselves to this class of construction.

At the time of the founding of the American Concrete Institute, 20 years ago, the industry was fairly well established in Europe and had gained firm foothold in this country. A number of types had been developed. Designers had boldly explored the unknown possibilities of concrete and reinforced concrete. In the enthusiasm of youth they sometimes marched on where "angels feared to tread." Practice was years ahead of theory. In general, experience and designing instinct rather than sound scientific training guided the builder. In spite of the apparently large number of successful examples that could be pointed to, the layman, and indeed, the average engineer, was uninformed and hence skeptical of the "new-fangled notion." But the pioneer period was drawing to a close. A new period began in which a sound theory of design was developed and supported by a vast amount of research and experimental data. Economic advantage broke down the resistance on the part of the public to new methods, and skepticism was forced to give before an ever-increasing volume of facts.

While it may appear that the art was fairly well developed prior to 1904, this is due to the fact that we have attempted to review the development in all the years before that time. Every great industry is a process of growth, generally slow at first and subject to wide variation in rate of development. New ideas and methods take time to "sink in" and be accepted, especially by the public at large. Therefore, 20 years ago, despite the fact that scattered over the world one might find hundreds of concrete and reinforced concrete bridges, that most of the types that we know today had been tried out in a tentative way, nevertheless, this was known only to a few who specialized in this work. As a matter of fact, the construction of a concrete bridge 20 years ago, even of moderate dimensions, was generally considered an achievement. The project was regarded as an innovation, and grave fears and doubts had to be swept away before a favorable decision was reached. After the job was finished and the false work removed, those responsible for the design and erection would heave a sigh of relief and appear to be pleased that the expected had happened—the bridge was still there—and that their own doubts were groundless. Each new structure was a new experience and served as data for the design and building of the next one.

Indeed, experience was the guide rather than theory in determining the dimensions of the structure. The theory of the elastic arch had been stated by Weyrauch as early as 1879, had been developed and restated in various forms by later authors, and was available in standard textbooks on mechanics. But the subject seemed to bristle with mathematical difficulties, and the impression was common that it was quite as much an achievement to produce the design as it was to produce the structure. The bridge engineer had inherited the voussoir method of building arches from earlier builders reaching back to the Roman period, and the idea that a stone or concrete arch was an elastic structure, subject to changes in form due to the applied load as well as expansion and contraction with changes in temperature, was not generally believed important.

In the past twenty years this situation has completely changed. The experimental stage has passed. We have in the last decade or two been stabilizing and consolidating theory and practice. We have learned more about the properties of concrete, its limitations as well as its possibilities, in 20 years than in all the time prior to that. On every hand we see reinforced concrete bridges replacing older and less permanent structures. Memorial and monumental bridges of reinforced concrete have become commonplace. Today reinforced concrete is a standard structural material. Methods of design are standardized and the common property of well-informed structural engineers, instead of the special and, in some instances the mysterious, knowledge of a few specialists. Standard specifications and more or less standard methods of constructions are the rule rather than the exception. We are in the midst of a period of standardization. It is indeed the order of the day, and sharply marks the difference between our present situation and that of 20 years ago.

While we are apt to judge the future in the light of the past, it seems incredible that the next 20 years will see as intense and rapid a development as the last 20. We shall, in all probability, develop some new types of concrete bridges, erect structures more imposing and larger in scale than those of today. We may reasonably expect improvement in the materials of construction, especially in the strength and reliability of the concrete. We may see the actual construction of such structures as the proposed Henry Hudson Memorial Arch with its 700 ft. span, more than doubling our present record of length of arch span. But beyond the boundaries of our present knowledge lies the land of tomorrow, and what we shall find there is a matter of speculation. Let us hope, however, that the next 20 years will show as large a measure of the achievement as the past 20.

Concrete Street Paving in 1923

Extensive paved street systems a few years ago were held to be things which only the cities could have, and if a town or village adopted a paving program, it very likely called for nothing more than the paving of three or four of the principal blocks on "Main Street," says a bulletin of the Portland Cement Association.

In recent years, street paving has been widely extended in the smaller towns and villages. Towns of a thousand or so now point proudly to pavement all the way through the business section, and on the more important side streets as well.

Consider statistics on concrete pavements in several places with less than 3000 population. In Shorewood, Wis., which has a population of 2650, concrete street pavements totaled 261,483 sq. yd. on January 1, 1924. This would make approximately 26 miles of pavement 18 ft. wide. This is an average of approximately 98 sq. yd. of concrete pavement per capita. Glen Ellyn, Ill., with a population of 2851, had 251,939 sq. yd. of concrete street paving.

With only 1311 people, Garner, Iowa, has 101,000 sq. yd. of concrete pavement on its streets. Mifflinburg, Pa., population 1744, had 36,800 sq. yd. of concrete pavement at the beginning of 1924. Whittier, Calif., with 7997 people, had 260,117 sq. yd. of concrete street paving.

By far the greatest year for street paving was 1923, when contracts for 24,385,497 sq. yd. of concrete street pavement were awarded, or almost 6,000,000 sq. yd. more than in 1922, the next highest year. At the end of 1908, the concrete street pavement in the country totaled 444,864 sq. yd., the equivalent of 44 miles of 18-ft. pavement. January 1, 1924, the total built or under contract was 110,020,712 sq. yd., or the equivalent of 10,450 miles of 18-ft. pavement.

Concrete Block Building in England

(From a British Correspondent)

An interesting example of concrete block and unit construction in England is shown in the accompanying illustrations. It is The Central Garages, recently erected at Hedge Lane, Palmer's Green, London, N. 13, England, for J. J. Gates.

The main roof covers a total area of 9000 sq. ft., which is divided into a workshop, showrooms, offices, and 16 car lock-ups. At the rear of this main building are an additional 55 lock-ups previously erected, from the construction of which the proprietor gained the experience and good opinion that decided him in favor of the concrete unit for the larger building.

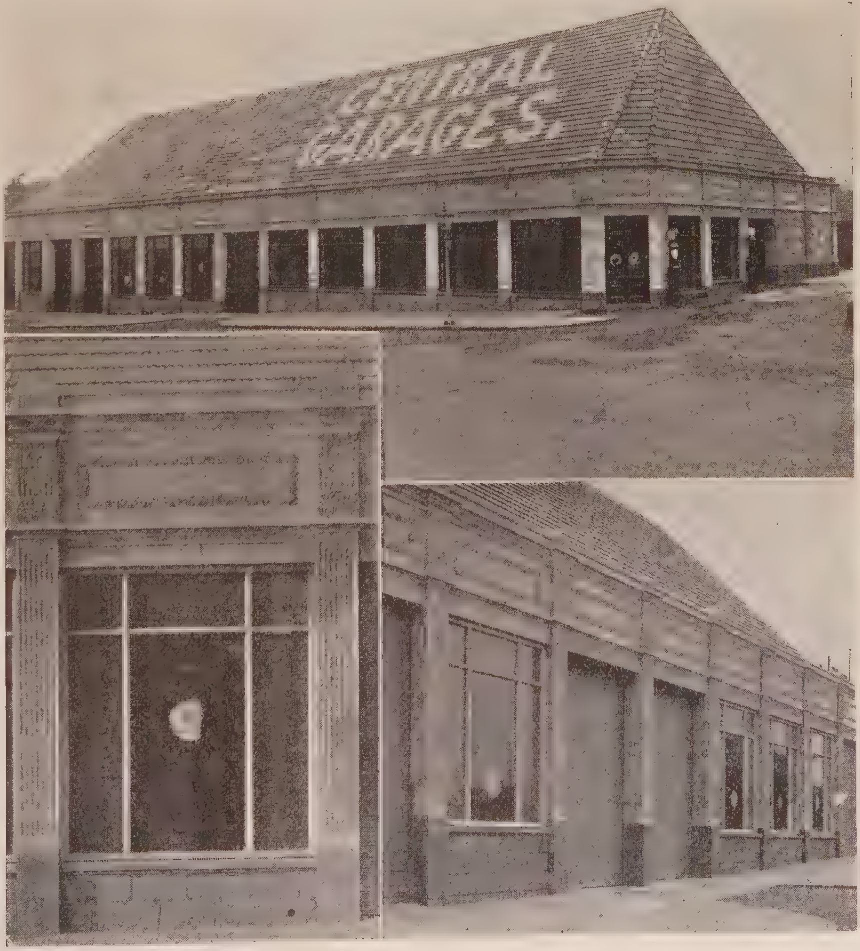
The units range from plain 3-in. cinder breeze partition blocks to the ornamental molded work of the pilasters, lintels, and cornices. Being a question of economy, as compared with ordinary brickwork, and of utility rather than appearance, there could be no pretence of artificial stone set slowly and carefully to ⅛-in. or less joints, but the best that could be made of blockwork that was frankly molded concrete, either as plain block or ornamental castings.

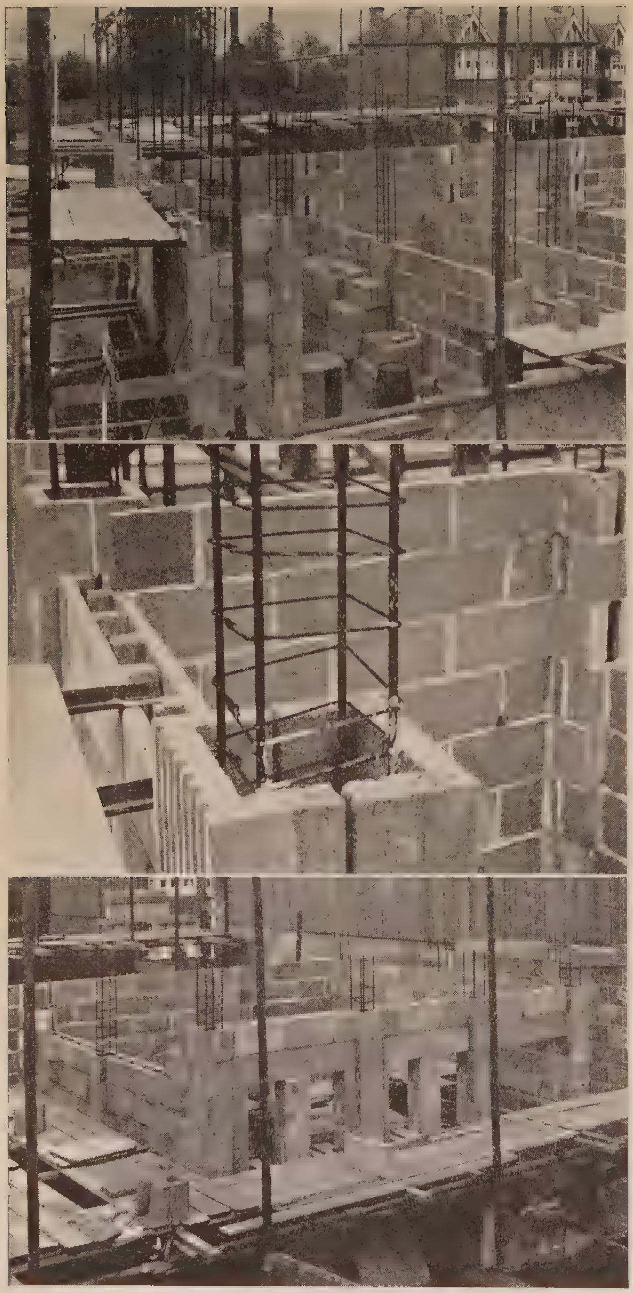
The material was manufactured by Messrs. Concrete Manufacturers (No. 1 London) Ltd., of Brimsdown, Middlesex, with Charles Marques, architect, who invented the system used (Figs. 7 and 8), as architect for the block makers. The result is one of the finest concrete block constructions in the country. It is intended in the near future to add an additional story with concrete floor.

The construction consists of units of the E, F, L, T, and U shapes, built around the reinforcements, and filled with a bearing area of concrete as the work proceeds, usually and preferably by filling in to half-course height, so that the mass of poured concrete breaks joint with the block unit, thus preventing undue lateral thrust to the last built block. Piers may be constructed within the cavities of the T wall units, or pilasters formed as required.

The partitions between lock-ups, etc., being of small extent, are 3 in. thick, all built to 3 courses of stone concrete, all courses 12 in. high, and above that, good breeze concrete. Constructional views are seen in Figs. 4, 5, and 6, where it will be noted that the wall is bonded to reinforced piers. Piers carry the concrete girders cast in situ, which are intended to support the superimposed load when the other story is erected.

Figs. 1, 2 and 3—Precast Units Employed in Unusual Garage Construction at Brimsdown, Middlesex, England





Figs. 4, 5 and 6—Garage Under Construction

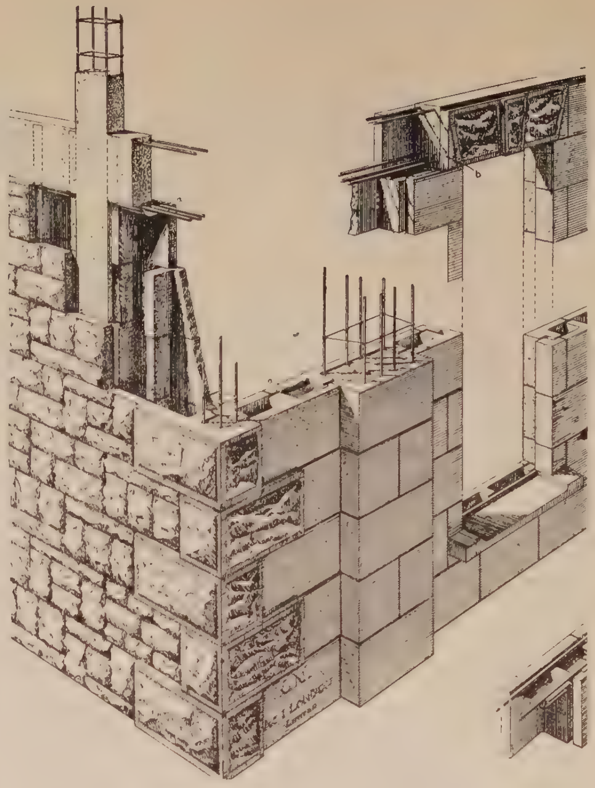


Fig. 7—From Patent Drawing Showing System of Construction

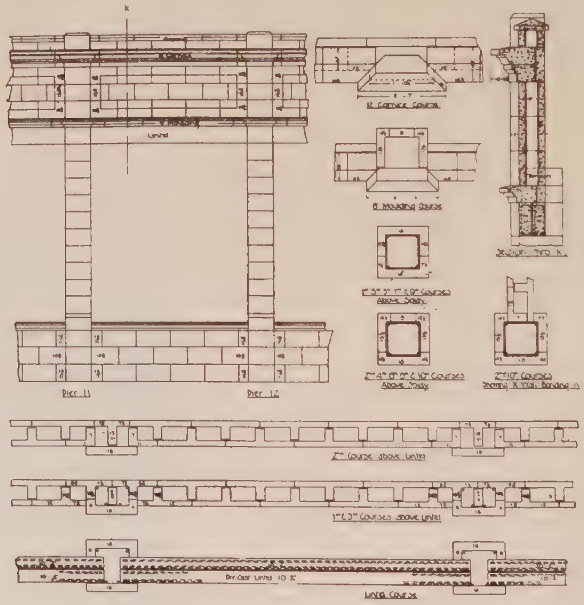


Fig. 8—Some Details of the Garage Illustrated

The whole of the pier casings, as well as all external block work and main wall, is of good quality stone concrete, left rough or faced with fine finish and colorings, according to positions.

All concrete units are steam cured, and of a mix designed to be impervious. The company's technical management having an extensive experience in this class of work, has long used a mix of water percentage that is now recognized as giving the best results, while the facings are gauged to equal the expansions and contractions of the mass, so that crazings from inequalities of this kind are entirely obviated

Mr. Marques stresses the importance of proper facing mixes, as specifications frequently contain instructions which make the body of the stone of poorer mix than the facings. "When stone is specified not of equal and fine mix throughout, the mass, particularly when under compression, should be of slightly richer matrix than the facings, especially when projecting as moldings, etc.," says the architect.

The building stands upon a site which has a fall of 6 ft. from corner to corner diagonally; also, the foundation soil was so varied in bearing value that footings were rarely duplicated, either being carried down to further bearings or spread to gain capacity. Fig. 1 gives some idea of the fall. The floor inside is on two levels, the higher being 3 ft. above the level of the lower. For convenience of storage, etc., the lower end of the building (the first 8 panels) was completely finished before proceeding with the remainder. Fig. 3 gives a view of this part. Fig. 2 is a window panel between two of the doors, and shows the fluting, reeding, and other ornaments cast in the blocks forming the piers, as well as the panels forming the lintels and frieze. The lower dark portion of the facade is of mottled red and black facings cast with the block; the sills being treated in the same manner. The upper portion is of pale buff, being actually a mottling of two buff facings, light and dark, cast haphazard. The precast lintels over doors and windows are reinforced for all anticipated loads, and are in two parts, the outer one conforming to the exterior facings, and the inner to the plain concrete facings of the interior. Making these in two parts permitted face-down work on both exposed faces and gave convenience of handling.

When supplying material of this kind, the block company provides a complete set of detail drawings, which show every block in elevation and all variations in plan. Fig. 8 reproduces part of sheet showing details of the front elevation. No block of ordinary size and shape is figured in the drawings, but all shorts and odd shapes and sizes are marked in dimension and supplied accordingly.

Fig. 1 illustrates an expanse of roofing which is probably one of the largest concrete tile roofs in the kingdom. The name picked out in white tiles contrasts vividly with the rich red of the general tiling; this name being placed at one end to form a complete sign, centering to a vista seen at some considerable distance. The steep pitch was designed to contain, when re-used over the second story, a ceiling which will arch high into the space between the levels of plates and ties. With the intended story and higher parapet, it will appear less prominent. Roof tiles used are of the reform pattern, with storm heads and double side locks which permit very small lap both ways. Every fourth tile has a galvanized wire cast in, which may be attached to the battens. There are only 130 tiles to the square, which weighs 700 lb., or about half the weight of the usual clay tiling. The half-round ridging is also of colored concrete.

The whole of the wall and other concrete work, including floors and several large girders, cast in situ to hold machinery, was done by direct labor employed by the owner, adhering exactly to the specifications.

The cost compares favorably with other adequate methods of construction, while in appearance the whole structure is comparable with, though not an imitation of, cut stone. The architect's idea being to punctuate by bold jointing the conveyed sense of units assembled into a harmonious entirety.

Mile Posts and Whistle Posts of White Portland Cement Concrete

All mile posts and whistle posts for the New York Central Railroad are now made of white portland cement concrete. These new posts replace the old cut stone and wooden mile posts and the old wooden whistle posts. Cut stone mile posts used on the main line were durable, but quickly turned grey and were becoming expensive. On branch lines, the mile posts were usually of wood bolted to two pieces of old rail embedded in the ground. Whistle posts were of wood, about 9 in. in diameter, turned from a log, about 9 ft. long with the lower 3 ft. embedded in the ground, left unturned.

The replacement of both the stone and wooden mile posts and whistle posts by posts of white concrete has meant a large initial saving in cost. The new type whistle posts cost to manufacture last year, approximately $4.50, including labor, materials and forms. The cut stone mile posts cost about twice as much, while the wooden mile posts cost about $1.00 apiece more than the white concrete posts.

Wooden whistle posts cost from about $6.50 to $7.00, while those of white concrete cost about $4.35, including labor, material and forms.

These posts are made by the company forces at the storeyards of the Building and Bridge Department.

The design of the mile posts and whistle posts is shown in the details, and their finished appearance in the illustrations from photographs. The forms are simple, but well made, so as to be used repeatedly. For the whistle posts, the "W" is recessed by nailing wooden strips to the forms. In casting the mile posts, which have to have different letters and numbers, reversed cast-iron letters and figures are secured to the forms. The recessed letters are then painted black.

The forms for the whistle posts are illustrated. The forms for the mile posts vary in that the form is for the two faces and one side, and the pouring is done with the form on edge. Rapping of the forms with a hammer as the concrete is poured gives a dense concrete and prevents surface imperfection. The exposed side is trowelled to a smooth surface. It is desirable to rub the surface with a little sand and water to remove

FIGS. 1-3—MILE POSTS AND WHISTLE POSTS OF THE NEW YORK CENTRAL RAILROAD—CENTER, MOLDS USED FOR MAKING WHISTLE POSTS

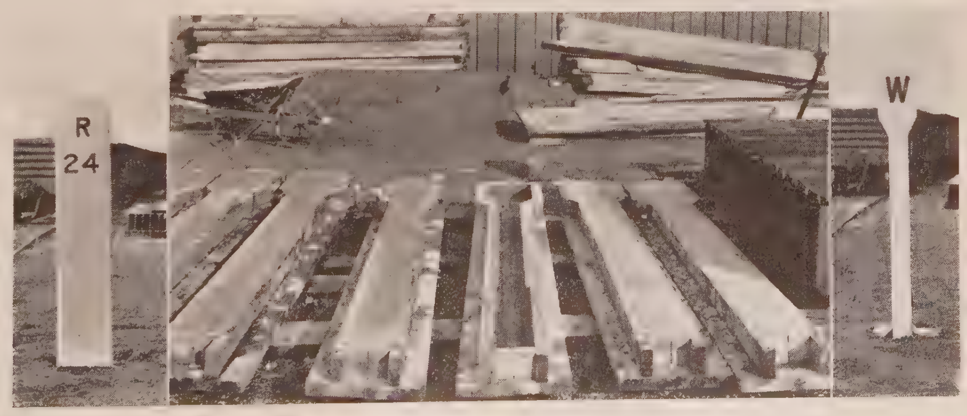
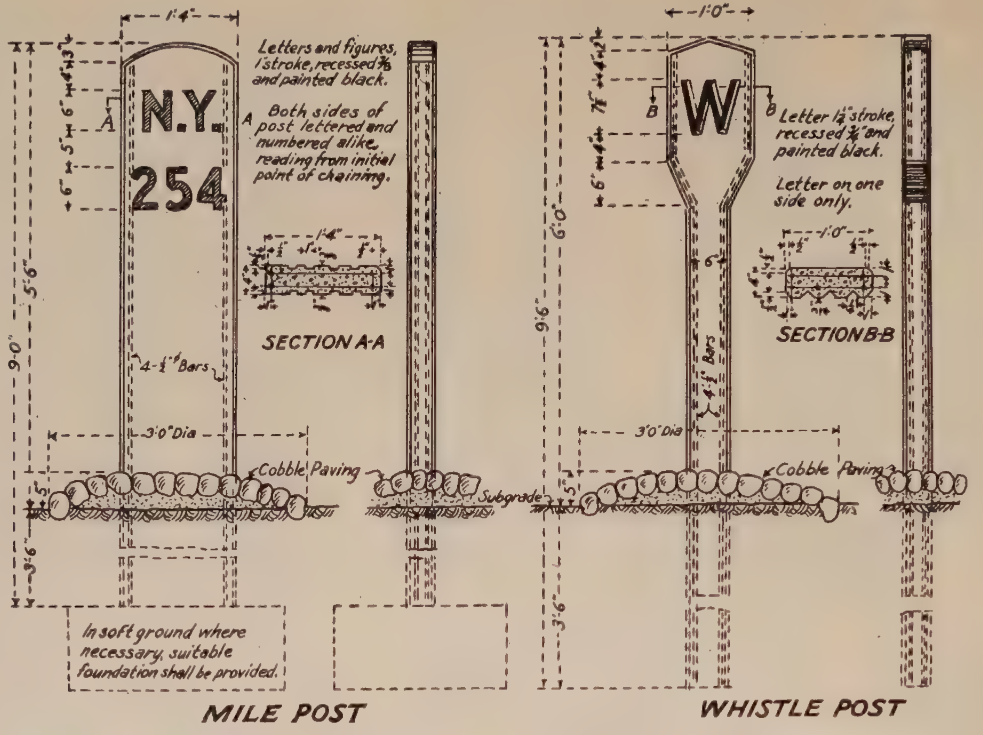


Fig. 4—Details of Mile and Whistle Posts


1'4"
N.Y.
254
A
Letters and figures, 1 stroke, recessed 3/8 and painted black.
Both sides of post lettered and numbered alike, reading from initial point of chaining.
SECTION A-A
4-½" Bars
3'0" Dia
Cobble Paving
Subgrade
9'-0"
5'-6"
3'-6"
In soft ground where necessary, suitable foundation shall be provided.
MILE POST
1'0"
W
B
Letter 1¼" stroke, recessed ¼" and painted black.
Letter on one side only.
SECTION B-B
4-½" Bars
6'0"
9'6"
3'0" Dia
Cobble Paving
WHISTLE POST

the skin coat of neat cement that the trowelling and suction of the form bring to the surface.

The mixture used consists of one part of Atlas-white portland cement, two parts of white sand, and four parts of white gravel passing a ¾-in. screen. The reinforcing bars are laid in concrete as it is poured.

After removal from the forms, the posts are kept wet by sprinkling with water until thoroughly cured, and are ready for placing in about a month.

The mile posts require .225 bbl. of white portland cement, .066 cu. yd. of sand, .132 cu. yd. of gravel, and four ½-in. round rods, 8 ft. 6 in. long.

The whistle posts require .10 bbl. of white portland cement, .03 cu. yd. of sand, .06 cu. yd. of gravel, and four ½-in. round rods, 9 ft. long. For the foregoing, Concrete is indebted to Samuel Warren, Assoc. M. Am. Soc. C. E., manager Atlas-white Dept., Atlas Portland Cement Co.

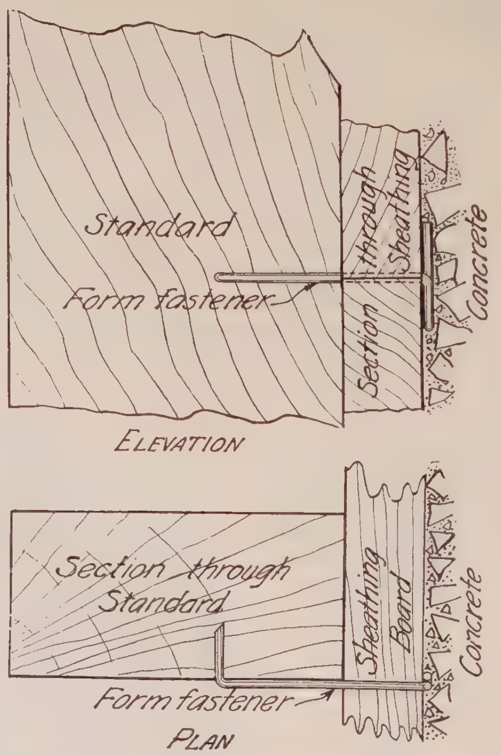
New Fastener Saves Form Lumber

A recent improvement in building construction, which has resulted in economy in time and labor, is the Bull-Dog concrete form fastener, perfected and placed on the market by Hommel Manufacturing Co., Inc., of Oakland, Calif. The new device replaces nails in the erection of concrete forms. It is claimed for the fastener that much time is saved in erecting concrete forms, as one fastener takes the place of two nails, and that a saving of 20% in labor is effected, the device being more easily handled than nails and doing twice the work.

A great saving in lumber is brought about by the fact that the same lumber can be used repeatedly in the erection of concrete forms. Under the old method, nails had to be driven in such a manner as to make them extremely hard to extract after the job was finished. Because nails were used, much of the lumber was splintered and reduced to waste in tearing down the forms.

The new concrete form fastener does not splinter lumber, but merely binds the form together until the job is finished. Removal of the fastener is simple and easy.

In erecting a concrete form, one fastener is driven into every alternate stud and is ready to receive the next board. The new concrete form fasteners are recommended for use in the erection of concrete forms for concrete foundations.



Elevation and Plan Diagrams Illustrating the Method of Using Form Fasteners to Replace Nails for Holding Form Sheathing to Standards

Long Span Arch Built Over Old Bridge

After four years of construction, interrupted at times by lack of finances when they were needed, and by a fire which destroyed much of the falsework, Minneapolis has added another bridge spanning the Mississippi river at Franklin Avenue, by completing the Cappelen Memorial bridge, which has the largest single reinforced concrete span in the country.

This monumental structure has attracted scores of engineers, including a few from foreign countries. Sweden particularly has manifested an interest in it because a bridge is to be built in Stockholm which will have a single concrete span of even greater length than the 400-ft. span of the Cappelen bridge. Three engineers from Sweden recently visited Minneapolis to inspect the structure. Its construction was begun in 1919 and completed in 1923, the official opening taking place on December 7 of last year.

The total length is 1100 ft., containing three large and two small spans. The longest span is 400 ft. and is one of the longest concrete spans in the world. Two spans are 199 ft. each and the other two are 55 ft. each.

The piers are 40 ft. thick at their greatest dimensions and rest on sand rock bases.

The deck consists of a 40-ft. roadway paved with creosote wood blocks with two 8-ft. sidewalks supported on brackets, the total width being 60 ft. from rail to rail. The river gorge is about 900 ft. wide with the distance between edges of the bluffs 1,100 ft., the banks being about 100 ft. high. Double tracks for street railways were provided.

It cost approximately $950,000 and was started in 1919, when common and skilled labor were paid 50 and 80 cents an hour respectively, while at the finish the rates were 62½ cents and $1 an hour.

About 35,000 cu. yds. of concrete were required in the difficult construction, the bridge being built under and on the sides of the old structure so as not to interfere with traffic at this important point.

Flood lights furnish the illumination at night but these will be replaced by 26 ornamental lamps.

The general design was worked out by the late F. W. Cappelen, city engineer, with the details carried out by Kris Oustad, bridge engineer. City Engineer N. W. Elsberg was in charge of construction until Mr. Cappelen's death. When Mr. Elsberg succeeded Mr. Cappelen as city engineer, the construction work was turned over to F. T. Paul, with J. E. Lundstrom as general foreman and William McCaulley master mechanic.

The bridge is situated in a residential part of the city, and forms another connecting link between Minneapolis and St. Paul, although both river banks are in Minneapolis. It replaces a steel structure about 30 years old.

Behavior of Cement Mortar and Concrete in German Bogs

In summing up some of the most important parts of the report of the special sub-committee of the German Committee on Reinforced Concrete on the behavior of cement mortar and concrete in some German bogs, F. J. Alway quotes the committee's conclusions in full in the *Journal of the American Peat Society* as follows:

> The following conclusions may be drawn from the behavior of the tiles during their exposure of almost 8 years:
>
> Thin walled cement bodies, such as the tile used, are not able to withstand the action of acid bog water for a long time. For buildings in bogs, the careful choice of cement and aggregate is a necessary prerequisite for the greatest durability. Good cements and clean quartz sand of mixed grain sizes behave best. If cement and aggregate are carefully selected, protective coatings may be dispensed with. So-called water-repelling additions of Tirili and potash soap have an injurious action in the acid bog waters. The thick pillars and piles will evidently withstand the action of the bog waters for many years without suffering an appreciable loss in strength and bearing power.

In his conclusion, Mr. Alway states that the task of the sub-committee was not to attempt to ascertain how large a proportion of peat soils will permit of the use of concrete without serious deterioriation but to determine to what attacks concrete is exposed in bogs, and how these may be avoided or their severity lessened. It selected the sites for the preliminary trials in the bogs only after making sure that harmful conditions existed in each—iron sulfide along the Elb-Trave canal and low-lime peat at Kehdingen and Bernau—while for the final trials with concrete on the Elbe-Trave canal, it selected the site where the preliminary trials had shown that the severest injury was to be expected.

It is reported as highly desirable that examinations be made of the concrete tile that have been laid for some years in the bogs in different parts of this country. Wherever serious injury is found, such investigations should include the examination of the adjacent peat for the presence of iron sulfide (pyrite or marcasite) and soluble sulfates, and also, wherever the peat is found to show a very strongly acid reaction, the determination of the lime content.

The following is abstracted from Mr. Alway's summary of the report. The experiments were conducted at the national bureau for testing materials in Berlin and in the laboratory of the German Association of Portland Cement Manufacturers at Karlshorst.

> The first important reference to injury to concrete in contact with peat appears to be the case in which a cement drain partly laid in peat in 1903 showed serious injury after a few months' use. The

deterioration was found to be due to the oxidation of the unusually large amount of iron sulfide contained in the peat, forming sulfuric acid and ferrous sulfate.

The task of the sub-committee appointed is defined as: "to determine by practical trials whether the different kinds of concrete are suitable for foundations in high-moors and low-moors,[1] to what attacks they are exposed and how such attacks can be avoided or rendered harmless."

Distinction was to be made between concrete mixed with pure water and that made with bog water and also between well cured and green concrete.

The experiments fall into two groups, the preliminary experiments with cubes and tablets of cement mortar exposed from 1910 to 1913 and the main experiments with concrete structures put in position in the bogs in 1912 and removed partly in 1914 and partly in 1920 for laboratory investigation.

Experiments wtih Low Cement Mortar

For the trials of different mortars the sub-committee selected seven sites. Five of these were near Lubeck, three being on the Elbe-Trave canal, which cuts through a low moor, carrying considerable iron sulfide, and two on the Kehdingen high moor. On the Elb-Trave canal each site was to represent a specific condition, viz: No. 1—Peat with a low content of iron sulfide. No. 2—Peat with a medium content of iron sulfide. No. 3—Peat with a high content of iron sulfide.

A detailed chemical examination was made of the mortar samples after they were removed from the sites. Chemical changes were slight during the first six months but increased with time and in two cases the samples had fully disintegrated at the end of three years. The analyses showed so many contradictory results that generalizations are difficult. The character of the mixing water had no influence upon the resistance. The lean mixtures, being more porous than the rich, were more altered. The chemical effect was most dependent upon the site. Flowing bog water attacked the mortar more than still bog water and the high-moor more than the low-moor. Without accompanying determinations of strength chemical analyses are liable to lead to erroneous conclusions concerning the weakening of the mortar.

Experiments with Concrete

The most important work of the sub-committee was the testing of concrete structures at three sites, viz., at Guster on the Elb-Trave canal, where iron sulfide was most abundant in the low-moor, in the Kehdingen high-moor and in fresh water at Trebbin. In 1912, at each place, large concrete tile, reinforced piles in which the concrete was poured, as well as tamped concrete piles and pillars cast in place, were put in and since then have been kept under observation, part being removed for laboratory examination in the summer of 1914, others in the summer of 1920, while still others have been left in place for future examination. The tile presented a large surface to the attack of the bog water and in one of the two bogs showed serious injury during the eight years' exposure, while the pillars and piles were at most but little affected.

The tile had an inner diameter of 29.5 cm. and a wall thickness of 4 to 4,5 cm. and were so supported that they were at the average water level in the bog. All were made at the same factory and 90 or more shipped to each of the three sites after they had been well air-cured. Two cements and four different sands were used.

The sub-committee recommends for tiles to be laid in bogs, the use of a mixture of one part of asphalt with ten parts of coal tar, dipping the tile into the hot mixture, and a similar treatment for piles. It emphasizes the importance of using well cured and well aged concrete made with a dense mixture.

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[1] Peat soils fall into two great groups—high lime and low lime—when considered from the standpoint of agricultural reclamation. The high moors have a slightly convex surface and are all low-lime bogs, while the low moors are flat or even slightly lower in the center than at the margin and, with occasional exception, are high-lime bogs.

Long Bridge to Be Concrete

The contract has been awarded and work begun on a concrete arch bridge over the Minnesota river, connecting Fort Snelling and Mendota, at a total cost of $1,860,000 in round numbers, which represents a saving of $104,000 as compared with the low bid on plans and specifications drawn up for a steel truss bridge on concrete piers with concrete roadway and sidewalks. The cost of the bridge complete will be $7.50 per sq. ft. of deck area, which is considered a very low cost under present conditions.

The bridge as designed is 4119 ft. long, has a 45-ft. roadway and two 6-ft. sidewalks. There are 12 arch spans, 304 ft. center to center, with a three-quarter arch span at the Mendota end and a short viaduct at the Fort Snelling end. The floor of the bridge will be practically level, the grade being 6 ft. higher at the Mendota end than at the Fort Snelling end. The deck will be about 120 ft. above low-water level, and foundations will be sunk approximately 55 ft. below low-water level.

The design is a 2-rib arch and flat slab floor supported on columns. The deck will be supported by ribs on the columns, and will consist of a flat slab, with depressions over the columns. The piers are each supported on 4 concrete cylinder caissons sunk to firm bearing. The caissons are 14 ft. in diameter, with cutting edges 22 ft. in diameter, and it is expected that they will be sunk by the open dredge method, building up the concrete shells as the caissons are lowered.

The roadway is 45 ft. clear between curbs, and designed to carry a double track street car line at a future date. The curbs are 11 in. high, with sidewalks 6 ft. wide on each side of the bridge between curb and handrailing. The handrailing will consist of reinforced concrete base and pedestals with steel panels between the pedestals. The paneled concrete posts will be 4 ft. 3 in. high, and the railing will carry ornamental lamp posts. The roadway will be paved with 2-in. asphaltic concrete.

The entire engineering work of the project, including location of the bridge and 5 miles of connecting highway, preliminary designs and estimates on three types of steel bridges and one concrete design, final plans and specifications for the two types of bridges on which bids were received, as well as supervision of construction is all being handled by Walter H. Wheeler and C. A. P. Turner Co. associated, as engineers on the project for Hennepin County, Minn. The Koss Construction Co., Des Moines, Iowa, are the contractors.

What Is a Good Concrete Brick, and What Is It Made Of?

From a Report by E. W. Dienhart of the Portland Cement Association and Stanton Walker, of Structural Materials Research Laboratory, Lewis Institute, Chicago.

What qualities should concrete brick have?

How are such brick to be made on a commercial basis?

What economies are to be effected in brick manufacture by selecting suitable aggregates?

The American Concrete Institute (Tentative Standards) tells us that a concrete brick should stand a 1500-lb. compression test and a 12% absorption test.

It may be desirable to make better brick than that, but suppose two manufacturers are going to make common concrete brick to serve the same territory and the same uses. One uses an aggregate that will make a 1500-lb. brick with a 1:8 mix; the other, because he doesn't know the fundamentals of concrete uses a third more cement to get a like result. Other things being equal, the second mand is beaten before he starts.

To find the *commercial* answer to the questions asked and to many other questions about concrete brick, a very interesting series of tests has been made. Tests, more often than not, are laboratory affairs. This series of tests was a factory affair with wheelbarrows for measuring.

E. W. Dienhart, of the Cement Products Bureau of the Portland Cement Association, and Stanton Walker, of the Structural Materials Research Laboratory, Lewis Institute, Chicago, report tests covering the manufacture of approximately 25,000 concrete common brick specimens. Physical tests were made of about 400 specimens, representing 72 variables of mix, aggregate grading, kind of aggregate and consistency, and 43 variables of curing and age at test. The investigation was carried out to demonstrate the application of principles of designing concrete mixes established by the Structural Materials Research Laboratory, to the manufacture of concrete brick. The practical result of this investigation is to establish fundamental relations between the variables of mix, aggregate grading, kind of aggregate, consistency and curing which will serve as a guide in manipulating these variables into the most economical cost combination for a brick quality of certain specified characteristics.

This series of tests was made possible through a cooperative arrangement between the Portland Cement Association, Structural Materials Research Laboratory, Philadelphia Brick Manufacturers' Association and Prof. N. D. Kolyn, in charge of the Department of Civil Engineering, Drexel Institute, Philadelphia. The National Slag Association, Cleveland, and the De Frain Sand Co., Philadelphia, furnished aggregates without charge.

The tests were outlined and the manufacture of the specimens superintended by Mr. Dienhart and Mr. Walker, assisted by R. S. Ridge, Philadelphia Office, Portland Cement Association. Prof. N. D. Kolyn, Drexel Institute, Philadelphia, carried out all compression tests on ages up to 28 days. Later age compression tests and all absorption tests were carried out at the Structural Materials Research Laboratory, Lewis Institute, Chicago.

Outline of Tests

The program of tests as originally outlined called for tests to determine the effect of the following factors on the strength and absorption of concrete brick:

1. Quantity of Cement: Mixes of 1:3, 1:5, 1:7, 1:9, 1:12 by volume.
2. Grading of Aggregate: Range from very fine sand (fineness modulus 1.50) to extremely coarse graded aggregate. (Fineness Modulus 4.75).
3. Kind of Aggregate: Sand and pebbles; crushed limestone screenings, crushed blast furnace, air cooled slag, crushed steam boiler cinders in combination with sand in the following proportions: 33%, 50%, 67% and 100%.
4. Consistency: Two consistencies to be arbitrarily gauged by the characteristics of the brick machine. A *wet* mix, using as much water as the machine could efficiently handle. A *dry* mix, arbitrarily reducing the amount of mixing water used for the wet mix by about one-half.
5. Curing. Treating the brick after manufacture to air, water and 1-2-3-7 day periods of time in steam, balance up to time of test in air.
6. Age at Test. Testing brick subjected to the above conditions of curing at the following ages, 1, 2, 3, 7, 14, 28 days, 3 months and 1 year.

Manufacture of the Brick

The specimens were made in the products plant of the South Philadelphia Builders' Supply Co., Philadelphia. This plant, a member company of the Philadelphia Brick Manufacturers' Association, was selected as a typical concrete brick plant. The brick were made on May 23, 24, 28 and 29, using a power tamping machine made by the Anchor Concrete Machinery Co., and a Blystone batch mixer (9 cu. ft. capacity).

Materials for the batches were measured in barrows and buckets previously calibrated by weighing the materials into them. The aggregates and cement were proportioned on the basis of one volume of cement to a given number of volumes of *dry* aggregates mixed as used. The water and cement for each batch was weighed on a platform scale. The water was first placed in the mixer, then the loading skip containing cement and aggregate for one batch was dumped into the mixer. In general, each batch was mixed for one minute after all materials were in the mixer, however, lack of sufficient help made it impossible to control this point without variation. The proper consistency of the mix was gauged by rubbing a sample of the mix upon the smooth surface of the mixer drum. When this test produced a film of water on the rubbed concrete surface, it was judged a proper consistency.

The mixed concrete was dumped onto the concrete floor, then shoveled into the brick machine hopper. The hopper was then put into position over the molds and the concrete was tamped into them. Each brick was struck five or six blows. The machine mold was divided into ten sections, making ten brick at one operation. The tamper had 5 tamp feet, each of which tamped two brick at the same time. After being tamped the brick were released from the mold on a wooden pallet then placed upon a car which when full was removed into a curing room.

Each batch of concrete was used before another was dumped from the mixer. For the purpose of making this series representative of actual plant manufacturing conditions and that the results of the tested specimens be indicative of general practice, three batches were made for every condition in this program. The samples of 5 specimens were selected taking two specimens from each of the first two batches and one specimen from the third batch.

The cement used was from the regular plant stock meeting A. S. T. M. standard requirements; the aggregates were all commercially available in the Philadelphia market. Tests of aggregates in table 2.

In carrying out this work, no change was made in the plant personnel, each man performing his regular duties.

What is a Good Brick?

In writing their report and in carrying out the work covered by it, the authors kept before them the following desirable characteristics that should obtain in common brick whether of concrete or other materials:

1. *Compressive Strength*: Common brick should be sufficiently strong to build a masonry wall of the strength required by the load for which the wall is designed. (Concrete brick have a higher degree of efficiency when built into walls than brick of any other material. Accordingly, individual concrete brick need not be as strong as brick less efficient in bonding with the mortar. The relation of the strength of concrete, clay and sand lime brick to the strength of masonry built of those materials is clearly shown by Bulletin No. 2, Columbia University, New York City.[1] (Fig. 1).

2. *Waterproofness*: A masonry wall must be water and damp-proof. While it is desirable for brick to have a degree of absorption which will permit an effective and ready mortar bond, they cannot be of a porosity that will permit the entrance of moisture through the wall. Such brick easily might have sufficient absorption to rob the mortar of considerable moisture, with consequent undesirable loss in bonding strength.

3. *Appearance*: Common brick when laid up in exposed walls must be of such color and texture as to produce pleasing effects. The natural gray color of concrete brick meets this condition. It is necessary however that the aggregate for concrete brick be of a grading and size which will produce the desired surface appearance. In this latter regard, the type of machine used has an important bearing. The method by which various machines tamp and perform the several manufacturing operations necessary to consolidate the material into brick, cause a variance in the surface texture of the completed unit. To develop maximum concrete strength from a given volume of cement, it is essential that a coarse grading of aggregate be used. It follows that the most efficient machine is that which will turn out the smoothest texture with the coarsest possible aggregate, and at the same time capable of speedy operation.

4. *Suction:* It is important that brick have a degree of absorption which will permit them to readily bond with the mortar in which they are laid.

5. *Weight:* The weight of common brick is an important characteristic. Ease of handling, speed of laying, transportation rates and the weight of the finished wall require that a brick be of moderate weight. A brick of standard size (2¼ x 3¾ x 8″) should not weigh more than five pounds, delivered on the job.

6. *Ease of Cutting:* The laying up of masonry walls requires a brick that can be readily cut by use of a trowel. If brick do not have the required degree of brittleness or do not make provision for this cutting by scoring or other means, it requires a chisel and hammer to cut them which annoys brick masons and reduces the number of brick laid per man day.

7. *Economical Combination of Materials:* Competition with other construction materials demands that concrete brick of a given quality be made with the lowest cost combination of cement and aggregate. The cement cost in concrete brick manufacture is generally the greatest element in the cost of manufacture. It follows that the most economical manufacturing process is that obtaining the maximum efficiency of the cement volume used.

8. *Speed of Manufacture:* The manufacturing cost of concrete brick is greatly influenced by the costs of labor and overhead. Any study of concrete brick manufacture must consider the effect that various combinations of kind, grading and size of aggregate, consistency, volume of cement, and amount of tamping required will bear on the possible production of the machine. It is important however that certain definite fundamentals necessary for concrete to attain strength be observed and practiced regardless of the possibility that such operation will not permit of attaining the rated capacity of a machine.

In discussing the results of tests made, the following requirements for concrete brick adopted (tentatively) by the American Concrete Institute were accepted as satisfactory standards:

Strength Requirement: 3. The average compressive strength of concrete brick 28 days after being manufactured or when shipped shall not be less than 1500 lb. per sq. in. of gross cross-sectional area as laid in the wall, and the compressive strength of any individual brick shall not be less than 1000 lb. per sq. in. of gross cross-sectional area as laid in the wall.

4. The gross cross-sectional area of a brick shall be considered as the product of the length times the width of the unit as laid in the wall.

Absorption Requirements: 5. Concrete brick shall not absorb more than 12% of the dry weight of the brick when tested as hereinafter specified except when they are made of concrete weighing less than 140 lb. per cu. ft., the average absorption in per cent by weight shall not be more than 12 multiplied by 140 and divided by the unit weight in lb. per cu. ft. of the concrete under consideration.

Guided by the desirable characteristics of concrete brick which should obtain and with the physical requirements in the tentative standards of the American Concrete Institute, the desire was to arrive at the particular brick of this series which best meet these requirements by the process of elimination in the following order:

1. *Strength*: Eliminating all brick which have a compressive strength of less than 1500 lb. per sq. in.

2. *Waterproofness*: All brick in this series meet the A. C. I. requirements for absorption.

3. *Appearance:* Eliminating brick which have surface textures which are quite rough, therefore probably not readily salable.

4. *Suction:* Eliminating all brick having an absorption of less than 100 grams (equivalent to cubic centimeters) after five minutes total immersion in water.

5. *Weight:* Eliminating all brick weighing more than 4.6 lb. *dry weight.* (This would be less than 5 lb. as delivered from stock pile to the job.)

6. *Ease of Cutting:* Eliminating all brick not easily cut with a trowel.

7. *Cost of Materials:* Eliminating 1:3 and 1:5 mixes as being uneconomical to manufacture.

8. *Speed of Manufacture:* Eliminating all brick of such combination of aggregate and consistency as to unduly slow up speed of manufacture. The only brick in this series that fall in that classification are those having a fineness modulus aggregate grading of 4.50 or over.

The full report of the tests involves tabulation of all the many test results. Table 1 outlines the process of elimination reducing the brick of the series down to the following numbers: 49, 56, 72, 75, 79, 81. The following table gives the composition of these brick:

Ref. No.	Kind of Aggregate	Grading Fineness Modulus	Wt. lb.	Test Results		Estimated for 1500 lb. Str.		Corrected Absorp. 24 hrs. Immersion
				Mix Used	Comp. Strength	Mix Recommended	Comp. Str.	
49	50% Sand—50% Cinders	3.38	3.9	1:7	1220	1:6	1530	7.8%
56	67% Sand—33% Cinders	3.17	4.0	1:7	1420	1:6.7	1580	7.7%
72	50% Sand—50% Slag Scrgs.	3.07	4.6	1:7*	1515*	1:8	1515	7.1%
75	33% Sand—67% Slag Scrgs.	3.18	4.3	1:7	1750	1:8	1525	7.7%
79	67% Sand—33% Slag Scrgs.	2.97	4.4	1:9	1455	1:8.7	1530	8.1%
81	Sand and Pebbles	3.50	4.4	1:9	1550	1:9	1550	9.3%

*Due to unaccounted for reasons the strength of brick made of 50% sand and 50% slag screenings is lower than is to be expected. This Ref. No. should have the same strength with a 1:8 mix as that obtained with a 1:7 mix.

Provided a maximum permissible weight of five pounds (dry weight) is assumed, the following reference numbers will be added to the above:

Ref. No.	Kind of Aggregate	Grading Fineness Modulus	Wt. lb.	Test Results		Estimated for 1500 lb. Str.		Corrected Absorp. 24 hrs. Immersion
				Mix Used	Comp. Strength	Mix Recommended	Comp. Str.	
24	Sand and Pebbles	3.50	4.9	1:7	1560	1:7	1560	5.7
33	Sand and Pebbles	4.00	4.8	1:9	1430	1:8	1540	5.7
169	Sand and Coarse Slag	3.20	4.7	1:9	1650	1:9	1650	6.1

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[1] See Concrete, May 1923 (Vol. 22, p. 167).

Government Committe to Study Cement and Concrete

A broad and scientific study of the properties of cement and concrete will be undertaken by the U. S. Bureau of Standards in conjunction with the Portland Cement Association as soon as the technical forces can be assembled. A program of activities has been endorsed by the Advisory Committee to the Department of Commerce on Cement and Concrete, the committee having been assisted by J. Walter Drake, assistant secretary of commerce, and by representatives of the Portland Cement Association, the American Concrete Institute, the Bureau of Standards and Division of Building and Housing, both of the Commerce Department, the Reclamation Service and the Navy Department.

A statement issued by the Department of Commerce includes the following:

> Besides utilizing the results of its own study of the problem, it is the purpose to secure from all laboratories, research institutions, organizations and individuals such information as they may possess regarding concrete as will permit the committee to recommend to the public the most improved methods for making and using concrete.
>
> The scientific research will include an intensive study of the chemical and physico-chemical properties of portland cements, of the raw materials from which they are manufactured and of the products into which they are converted when used in concrete. The investigation will involve a study of the pure ingredients, the influence of rock impurities and the natural deviations from the maximum composition, the temperature and time effects in manufacture, the reactions occurring in setting, the physical and colloidal behavior and hydration phenomena in setting, and the physico-chemical influence of many extraneous agents possibly affecting the material in service.

At the second meeting of the Advisory Committee, all the members were present as follows and in addition the various departments and organizations mentioned above were represented: John Lyle Harrington, chairman, engineer, Kansas City, Mo.; C. H. Boynton, cement manufacturer, New York, N. Y.; N. Max Dunning, architect, Chicago, Ill.; H. C. Turner, contractor, New York, N. Y.; Charles M. Upham, highway engineer, Raleigh, N. C.

F. W. Kelley, president of the Portland Cement Association, presented the outline of the investigation on portland cement through the cooperation of the Bureau of Standards and the Portland Cement Association. In brief the program comprises the following:

PRELIMINARY PROGRAM—The following program has been prepared as a preliminary method of attack:

1. Study of available literature on the constitution of cements and related topics
2. Consideration of related problems which have a bearing on the manufacture and use of cement
3. Outline of tests

A. Studies of pure compounds. Preparation of some of the important compounds in cements. These are to be prepared in small amounts, from pure, or relatively pure materials. They are to be subjected to the following:

1. Petrographic examination
2. Chemical analysis
3. Behavior on hydration
4. Other chemical and physical studies

The objects of this work are: To check results obtained by other investigators and thereby provide a starting point for further studies and to extend our knowledge of the physical and chemical behavior of these compounds.

B. Studies of impurities. Repeat *A*, except introduce some of the impurities present in commercial cement (such as NgO, Fe^2O^3, Na^2O, etc.) and study the effect on the formation of the compounds and on their hydraulic properties.

C. Manufacturing cements in experimental kiln. Similar to *B*, except prepare the compounds in larger quantities in a small rotary kiln so that in addition to the petrographic and chemical studies, specimens may be made for tests of:

1. Soundness,
2. Mortar and concrete strength,
3. Effect of destructive agencies—(alkali, sea water, peat soils, etc.)

D. Studies in existing cement plants. It is intended to take advantage of the possible wide variety of compositions and physical characteristics of raw materials existing in the industry to study the effect of these variations on the properties of the finished cement. The study of the finished cement would follow the lines indicated above for the purer compounds or laboratory prepared cements but would be extended to close observation of the conditions and methods used, as affecting the quality of the cement, existing in the plant, and to the larger and more detailed study of the resulting cements in various services.

E. Hydration of cements, studies of catalysers, etc.

F. Concrete-making value of cements. A study of the behavior of the special cements in concrete, following recent developments in other tests of this kind and applying standard methods to strength, resistance to weather and other destructive agencies.

The work outlined will be carried on jointly by the Portland Cement Association and the Bureau of Standards at the Bureau of Standards. It is contemplated that the Portland Cement Association will supply a staff of six engineers and chemists. This number will be augmented by a similar number from the Bureau. The entire equipment of the Bureau for this type of work will be available.

Atlas Aluminate Company to Manufacture Alumina Cement

After months of experimental manufacture, the Atlas Aluminate Cement Co., with main office at 25 Broadway, N. Y. C., has announced that it is now prepared to produce Lumnite high alumina cement at Northampton, Pa., in ample quantities to meet any demand as it develops.

For some time CONCRETE has been giving to its readers articles and discussions which have helped to create an active interest in the French high alumina cement, which shows, in 24 hours, a greater strength than that of portland cement at 28 days, and a resistance to the chemical attack of sea water and sulfate-bearing ground water. Although more expensive than other cements in its first cost, manufactured as it is from raw materials consisting largely of a high grade aluminum ore, the exceptional characteristics of this cement have developed in Europe a substantial market for the product. It can be readily appreciated that the peculiar characteristics of this material recommend it for many special uses even at a higher cost.

Cognizant of the apparent increasing demand among engineers and the construction industry generally for a cementing material of such special qualities, and desirous of keeping pace with all forward steps in the construction field, the Atlas Aluminate Cement Co. was formed after an investigation of similar cements in France, to acquire the so-called Spackman patents which cover, in this country, the manufacture of high alumina cement.

It is pointed out by Henry S. Spackman, who discovered and patented the product several years ago, which is new to America although in constant use for the last 12 years in France, that Lumnite cement is not quick setting. It allows the usual ample time for mixing, transporting and pouring in forms, but after setting, its high strength develops with phenomenal rapidity.

L. R. Burch, of the Atlas Portland Cement Co., is president of the Atlas Aluminate Cement Co.

Avoiding Warp in Forms

A reader of CONCRETE asked us how to prevent swelling and warping of form work. We passed the question along, and here are three interesting discussions.—Editor.

"Our experience has taught us that the best way to take care of form lumber on a concrete job in order to get a good surface when forms are removed, is to protect the dressed lumber from the weather when it is received, and wedge up carefully in making forms, using cleats, wedges, or dogs, says L. H. Usilton, general superintendent, Barney Ahlers Construction Corp. Grease or oil is then applied. Sun and wind will shrink these to a certain extent, but a good surface can be obtained if the forms are carefully wet just before pouring, so that the cracks are closed. This will take care of all form work up to about six uses. For any more uses, it would be necessary to do considerable patching of the forms and also pointing work after forms are removed."

"Usually it is not necessary to protect form lumber from moisture," writes William F. Lockhardt, of the Portland Cement Association. "The lumber, when it goes to the job, often is only a few weeks out of the woods, and is therefore about as full of moisture as it can possibly be. If it is made up into forms and used right away, the concrete will keep it fairly wet, and not very much trouble will be experienced with warping. If it is stored on the job for some time after it is received, it will air-season to some extent, and then, when the wet concrete is placed against it, it will swell and cause trouble. The form lumber which gives trouble in this connection is only the ⅞-in. material used for sheeting.

"If the forms are made up as soon as possible after the lumber is received on the job and form grease applied to the lumber, it can be held on the job for several weeks without very serious shrinkage or warping, as the grease helps to keep the lumber from drying.

"As far as storing lumber that has not yet been made up is concerned, I should say the best thing to do would be to stack it just the same as is done in a good lumber yard to insure even curing throughout the pile in a minimum of warping."

"A good deal depends upon the kind of lumber used," writes H. D. Loring, Ferro Concrete Construction Co. "Practically all of our form work is done with yellow pine, and it is not particularly subject to warping. On one or two jobs, in the past, we have tried hemlock, which warps and twists badly. One common trouble is the swelling of form work due to moisture. If forms are made of dry lumber in a mill and allowed to get wet, they may swell so much as to prevent their fitting in the spaces for which they were designed, or if they are erected dry and subsequently get wet, the swelling may throw the whole structure out of alignment or cause buckling of the decking. It is therefore necessary to allow for swelling in the design of form work. Our usual practice in connection with floor panels is to list them of such a width as to leave a gap of 3 or 4 in. in every bay of 20 ft. or so, and after the forms are erected, to fill in the gaps with strips made from measurements after all the other work is done.

"The oiling of form work with paraffin or other light oil, immediately after it is made, would probably reduce the shrinking. As a rule, however, forms are not oiled until erected in the building, and the oiling is then effective in reducing subsequent changes."

100 Varieties of Concrete Brick

The pictures show outside and inside of the Florida Nu-Tex Brick & Tile Co. plant at Tampa.

The Florida Nu-Tex Brick & Tile Co. was organized in August, 1921, and sold its first brick September 6th of the same year. Greene F. Cannon has been managing the plant since February, 1922. Sales have increased rapidly, and the plant has been operating at about half its capacity of 150,000 common or 30,000 face brick per day. The plant turns out over 100 shades of brick, and, according to Mr. Cannon, is in shape to match any clay brick offered on the market of America today. Domestic colors chiefly and some French and Spanish colors are used. Brick tested have run above 3057 lb. to the sq. in. The company makes flower pots, building tile, stone columns.

Lakewood Steel Subgrader

The 1924 model steel Subgrader (Lakewood Engineering Co., Cleveland) is adjustable in width from 18 to 20 ft., has an improved turntable pedestal, and provisions for cutting the special subgrade cross sections now frequently specified, which provide for a thickened edge slab.

Graded Aggregate:

News, Review, Hearsay, Comment—A Department of Fragmentary Miscellanies—the material for which will be gathered from the job, the office, the factory, over the lunch table, in Pullman smokers, from the morning mail and many other sources.

Stopping Floor Leakage

A question came to CONCRETE about the corrosion of reinforcement in a concrete floor slab where water came through the floor.

"Tell us," said the correspondent, "a method for treating a 4-in. reinforced concrete slab exposed both to sodium hydroxide and weathering. Owing to the rust produced in the steel, the concrete breaks off on the underside of slab, leaving the reinforcing steel exposed, which then begins to deterioriate very rapidly."

"Give this floor some sort of treatment in an endeavor to produce an impervious surface," writes the Portland Cement Association. "In this connection, refer to bulletin, 'Concrete Floors.' We suggest that the paraffin treatment be first tried for the purpose of sealing up the floor surface. If it be found impracticable to make the floor tight with any of the treatments referred to in the bulletin, we know of no other method than to place a new topping on the floor. This can be done, of course, by roughening the present floor surface and using the usual methods of placing a floor finish on a hardened concrete surface."

* * *

Getting a Hard Monolithic Floor Finish

"A job called for a 6-in. floor, either monolithic or with top coat, left to my discretion," writes Philip Weiss, Philadelphia. "I started to lay it monolithic, but for reasons I had no control of, I could not get the concrete of a consistency suitable for a monolithic finish. The finish called for hard trowelled finish with Master Builder filler. Ordinarily, I would have put on a 1-in. top coat, but as it was left to my discretion, I followed my own theory.

"I laid the concrete in such consistency that it did not *give* in tamping—which, by the way, I did not use—I believe that concrete should be laid with the rake in such a way that it needs no tamping. I rodded the concrete off with a 16-ft. 3-in x 12-in. plank. Then I took top coat of the usual consistency and mixture (1 cement to 2 aggregate consisting of half sand and half stone grit), and rodded that in well with the 16-ft. straight edge. Of course I only used a very little top coat—what I could work in between the stones of the concrete. By doing that I got rid of all the raw surfaces of the concrete, which the cement finisher either covers over with a grout or drier, in either case it is detrimental, as the surface is not of a uniform texture. The reason I used a 3-in. x 12-in. plank is because it was the handiest thing on the job. But, in any case, I believe that the heavier the straight edge, the better the results.

"The top coat merely took the place of a heavy grout, the only difference is that in this case it was uniformly spread over the whole surface. The rest of the finish was as usual. First floated with a wooden float; then sprinkled with Master Builder; then floated and trowelled; then another very thin sprinkling of Master Builder and another trowelling. We got a good hard trowelled surface.

"Necessity is the mother of invention. In this case, I had to use a thin coat of top dressing. But since then, I came to the conclusion that theory and logic would bear me out, that wherever a monolithic floor is called for, for heavy traffic, it should get a light top dressing of stone grit top coat. Of course, the problem of intimate binding has to be well taken care of by thorough working in of the top dressing.

"As is well known, the sand and the larger aggregates have not the same working qualities. Also, it is impossible to grade the aggregate so that the smaller aggregate should fill all the larger voids; consequently we find, after a few years, an uneven surface with the larger aggregate protruding. I think that my theory of top dressing would obviate that shortcoming of monolithic concrete floors."

* * *

Four Springfield (Ohio) Products Men Organize

The Clark County Concrete Products Association has been organized at Springfield, Ohio, with the following officers: president, Clem Beals, Springfield Cement Products Co., 460 Park Place; vice president, C. F. King, Springfield Cinder Block Co., 1076 Kenton St.; secretary, Elton L. Tavenner, Tavenner Concrete Products Co., 2594 Lagonda Ave.; treasurer, Frank B. Armstrong, Armstrong & Kaiser, North Belmont Ave., all of Springfield. A slogan "Quality Concrete Products For Permanence" was adopted. The officers represent the four manufacturers who are charter members.

* * *

Cinder Block Men After Higher Quality

The Second Annual Convention of the National Cinder Concrete Products Association (Straub patent licensees) was held in March in Philadelphia at the City Club, where the fourth floor was devoted to convention purposes; a private dining room, assembly hall, and display of advertising panels contributed by the member companies. A wholesome rivalry was established among the larger and more aggressive plants. The benefit of the quantity purchasing power of 50 plants was strikingly illustrated. This extends also to research, where greater activity is needed and a more unanimous effort at standard quality products. Among the after-dinner speakers were: A. J. R. Curtis, manager of the Products Bureau of the Portland Cement Association and R. Marshall, president of the Concrete-Cement Age Publishing Co. Quality products and prices sufficient to sustain the quality contention were the keynotes of the convention. It was announced that the present daily capacity of Straub plants is 133,000 8 x 8 x 16-in. blocks, or one Straub cinder block for every 9½ concrete blocks made in the United States, or the wall equivalent of 1,800,000 bricks per day. It was notable that men successful in other industries have been attracted to cinder block manufacture.

The following officers were elected: president, F. J. Straub; vice presidents, Henry Boettcher and Howard Brooke; secretary, J. Edwin Rutter; treasurer, G. Edgar Allen.

* * *

A Block of "V" Section

It is pointed out by Alvin Norris, 1413 South 13th St., Manitowoc, Wis., that the tendency for cracks to develop in brick walls is due to flat building units which do not offer a proper horizontal bonding effort. With the idea of curing the difficulty of cracks in the joints he has invented a brick of V-section and a triangular brick which is used for the starting and finishing courses with the V-shaped units. The triangular bricks are first laid on the footing leaving a surface in which the V-shaped blocks can be bedded; the idea being that these V-shaped units will offer considerable additional resistance to cracks and secure a bond in the wall that is better than can be secured with mortar alone.

* * *

New House Plan Book

A new House Plan Book will soon be issued by the Portland Cement Association to replace the Association's initial book "Concrete Houses," which was published last year. The new book will illustrate and describe forty different designs intended to be constructed of concrete block with portland cement stucco. These designs have been prepared by more than thirty prominent architects from the Atlantic to the Pacific and show truly architectural gems which come within cost estimates ranging from $3000 to $10,000. The new book will describe methods of concrete masonry construction, the use of stucco, and discuss fully various concrete building units, such as concrete block, brick, structural tile and roofing tile. The price—50 cents. Working drawings and specifications covering all the plans in the book will be available at nominal cost through the Portland Cement Association.

* * *

Increasing the Strength of Lime Block

Previous work by the Bureau of Standards indicated that when cast lime blocks have the same distribution of core space as gypsum blocks they will have about the same weight but less strength. It has been found that by changing the design of a block so that the total volume of core space is the same but is contained in two elliptical cores instead of four circular cores the strength of the block can be increased sufficiently to meet the requirements now put upon gypsum block. This work has been conducted in cooperation with the National Lime Association.

* * *

Progress in Cement Manufacture

The figures given in F. W. Kelley's paper, "Progress in Cement Manufacture in 20 Years" (American Concrete Institute, 1924), in the March issue of CONCRETE were those of 1922, due to the publication of an advance copy of the paper. The portion of the corrected paper is as follows:

In 1923 the total production was about 137,000,000 bbls., or 375,000 bbls. per day. This daily output is greater than the annual production in 1890.

The average output per rotary kiln in 1921, which is the last year for which official records are available, was 133,000 bbls., compared with 85,000 per kiln in 1910.

It is estimated that the cement plants in the United States used, in 1922, over 10,500,000 tons of coal, 4,700,000 bbls. of fuel oil, and 4,000,000,000 cu. ft. of gas.

There are probably over 225,000,000 cloth sacks in service handling cement today. Over 60,000,000 sacks are lost or destroyed per annum. A strip of cloth, 34,000 miles long and 30 in. wide, is needed to replace them. Over 43,000,000 paper sacks were used during the year. Over 38,000,000 lbs. of lubricants were used.

For the kiln linings, over 5,400,000 fire brick were needed, over 2,000,000 linear feet of belting were worn out, over 16,000,000 lbs. of explosives were used, and over 725,000 tons of gypsum were consumed.

The consumption of cement in the United States in 1903 was at the rate of .276 bbls. per capita. In 1923 this consumption was about 1.20 bbls. per capita. In 1922 there were 7 states in which the per capita consumption averaged 1.66 bbls. per person. The consumption in the country in 1923 was at the rate of about 450,000 bbls. per working day, 45,000 bbls. per working hour, 750 bbls., or 5 carloads, per working minute, and 12 bbls. per working second.

In 1923 the cement industry accounted for about 3% of the tonnage moved by the railroads of the United States.

In 1903 the world's production of portland cement was estimated at about 66,000,000 bbls., of which the United States produced about one-third.

In 1923 the United States produced about one-half the estimated production of the world, as follows:

	Barrels
United States	137,000,000
Germany and Austria	30,000,000
British Empire	35,000,000
France and Colonies	12,000,000
Japan	12,000,000
Belgium and Colonies	10,000,000
Others	30,000,000
Total	266,000,000

* * *

Slag

At the 7th annual meeting of the National Slag Association, 933 Leader Building, Cleveland, O., held at the Bureau of Standards and the Bureau of Roads in Washington, D. C., the following officers were elected for the ensuing year: president, C. L. Mc Kenzie, Duquesne Slag Products Co., Pittsburg; vice president, C. E. Ireland, Birmingham Slag Co., Birmingham, Ala.; H. J. Love, Leader Building, Cleveland, secretary-treasurer.

* * *

Lumber Company Makes 32-in. Block In Steel Molds

The Griffin Lumber Co., Hudson Falls, N. Y., has issued a 16-page pamphlet describing and illustrating the use of its wet process concrete block (cast in home-made steel molds), which are of unusual dimensions: 32 in. long, 9 in. high, and 10 in. or 12 in. thick. The 10-in. block have 1-in. walls, and the 12-in. block 2-in. walls. The booklet shows a variety of buildings erected with these units.

* * *

Varnishing Concrete Roof Tile

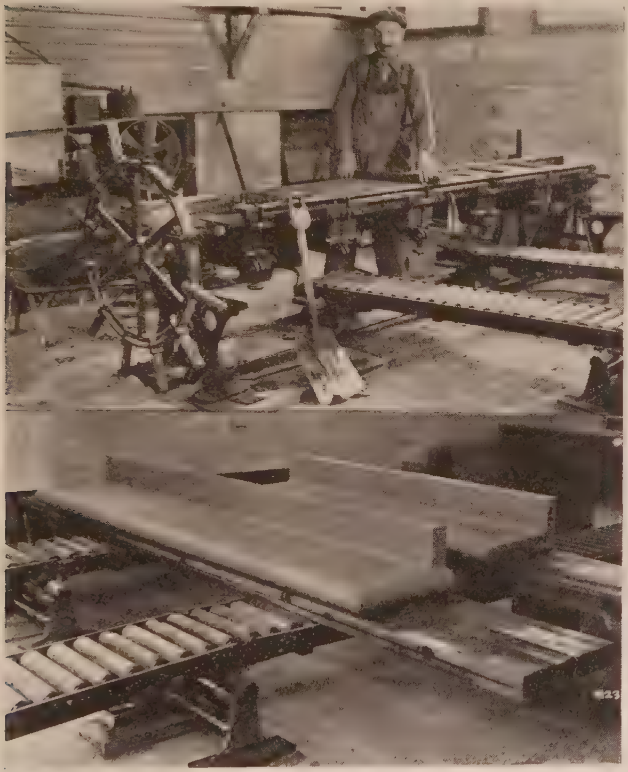
"Water-Resisting Spar Varnish," as specified by the United States Government, is considered in detail in U. S. Bureau of Standards Circular No. 103. This is mentioned because a concrete roof tile manufacturer received an order for tile recently and his customer demanded that it be varnished. Tile should be thoroughly seasoned before such treatment—which at best could not be expected to last long on a roof exposure. But when customers insist——.

Kent Step Machine

The accompanying pictures show not only the new Kent step machine (Kent Machine Co., Kent, Ohio), but the lower one gives some idea of the type of product it turns out.

The manufacturer of the steps furnishes with this equipment not only the tread and the riser, but also furnishes the jack which is used for supporting these steps. This jack is made in one piece, although apparently it is laid up of a series of blocks, all of this being formed in one mold, which is furnished with the step molding machine. The step molding machine makes the steps with the nosing on the end of the tread or forms the step flat without the nosing.

When the mason sets these steps, he first lays his footings. These footings project out from the wall of the house or porch and are made practically 8 in. wide to carry the 6-in. jack, which is set on these footings. These jacks are next leveled up on these footings in such a position that they receive the tread and riser which are made on the molding machine. The lowest riser is first placed in position and then the tread and riser of the next step is placed on top of the first riser. This process is continued until the entire step is made. The setting of the jack consumes the greater part of the time and the steps are very readily placed after the jacks are in position.



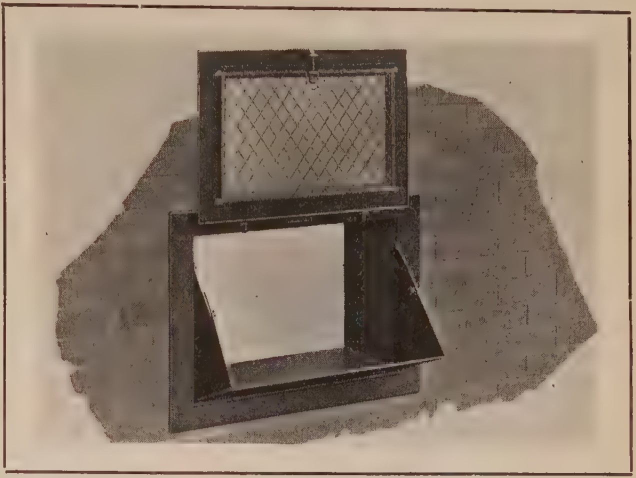
A thin layer of cement mortar is laid on top of the jack and on top of the riser of each step and the tread of the next step above is set upon this cement mortar bed. There is a depression on the under part of the step which allows the nosing to project down beyond the upper part of the riser of the step below, thereby making a fully concealed joint in the step.

These steps may be applied for the main approach of a house, may be used as porch steps for front or rear of the house or may be used as terrace steps. Any type of facing may be employed to blend with the architecture which may be used. Usually on the rear steps no facing is employed except the fine sand that may be used in the manufacture of the steps. For terrace steps it is a very simple matter to match up the type of color and grain that is used on the walk connecting these steps, thereby adding to the blending of the colors of the design.

The equipment necessary to make these steps consists of the concrete step molding machine proper—nine pallets for use with the machine; two units of roller conveyor which are installed for rolling of the finished step, and special mold for making right and left hand jacks for supporting the steps, and a special mold for making the first riser.

Gabriel Coal Chute

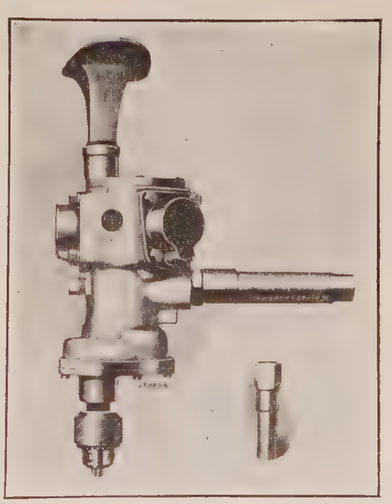
The picture shows the new Gabriel Coal Chute (Gabriel Steel Co., Bellevue Ave., Detroit, Mich.) made entirely of rolled steel; no castings. Doors, whether solid or glazed, are a one-piece rolled steel plate. Joints and frame are electrically welded. Hinges are of substantial rolled steel. Automatic, durable spring latch assures positive locking. Glazed doors have heavy wire glass, which is further protected by wire grating. The boot which goes through the wall is collapsible and folds against the back of the frame, making the chute only 3 in. thick and protecting both the boot and the glass. Four chutes take the place of one ordinary chute, saving in shipping, storage, and handling.



New Size Pneumatic Drill

A new size lightweight non-reversible pneumatic drill has been brought out by the Ingersoll-Rand Co., New York. This new drill is known as Size D, and is suitable for light drilling up to $\frac{9}{16}$ in. diameter holes, and reaming up to $\frac{5}{16}$ in. diameter.

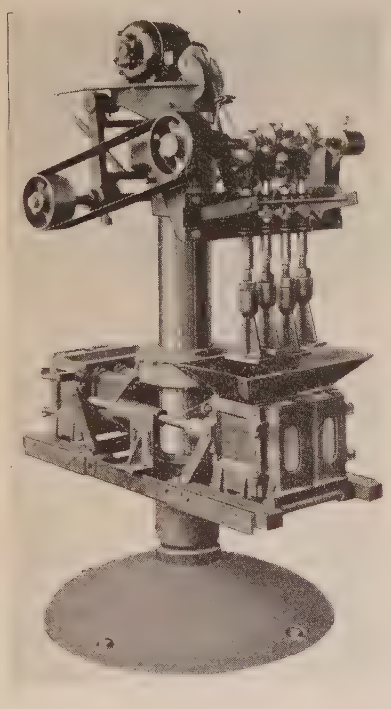
This is a lightweight drill which may be fitted with either breastplate, feed screw, or grip handle, and so made adaptable for a wide variety of work.



The features of this type of machine, as given by the manufacturers, are briefly—lightweight aluminum case, with steel bushings cast in all the bearing holes and the throttle hole; cast-iron cylinders which are remewable and interchangeable, and special three-cylinder motor.

Light-Weight Block Made Face Up for Facing

The picture shows the Utility light-weight block machine for power operation. The units, 5 x 8 x 12 in., are made face up, so that a facing mix with exposed aggregate can be applied. The unit weighs 20 lb. The webs in this block are so spaced that they come directly over each other in the wall, thus affording maximum load-bearing efficiency. Although the Utility machine is designed to be used primarily for the making of block by the face-up method, face plates may be used in the bottoms of the molds to make block face down. The machine is intended for uninterrupted production with a two-man crew. A revolving table has a mold on each end; it turns on ball bearings and locks in correct position. While one man makes a block, the other faces the block previously made and removes it from the machine. The labor is thus very evenly divided, and neither man is kept waiting for the other. Tampers operate at the rate of 600 blows per min., that is, 2400 blows per min. are struck by the four tampers, for thorough compacting of the concrete. Power is from an electric motor mounted out of the way of dirt and surplus concrete. The machine is put out by the Concrete Equipment Co., Holland, Mich.


UTILITY LIGHT WEIGHT BLOCK MACHINE

Trade Publications

The Blaw-Knox Co., Pittsburgh, Pa., has announced a plan that puts the purchase of standard unit steel buildings for every use on a "pay for them as they earn for you" basis—factories, machine shops, commercial garages, warehouses on the basis of household goods and automobiles.

Floor Surfacing is a circular of the equipment of the American Floor Surfacing Machine Co., 518 South St. Clair St., Toledo, Ohio, presenting a comparison of pay rolls on hand scraping and machine finishing of floors.

The Kramer Automatic Tamper Co., Peoria Heights, Ill. has just issued Catalog No. 7; 7½ in. x 10½ in.; paper covers. This bulletin describes and illustrates the Kramer automatic high speed concrete block and brick making machines which are designed to turn out blocks of any desired density and produce perfect and uniform blocks at the rate of 100 to 200 per hour.

The Ankyra Manufacturing Co., Philadelphia, has recently issued a folder setting forth the merits of its equipment, under the heading *Ankyra Ankor Bolts*. It is claimed for these bolts that they are permanent in the wall, give perfect ground alignment no matter how irregular the surface, are especially adapted in placing fixtures in bathrooms, attaching shade fixtures, locks, handles, and for holding heavy weights in brittle or weak lath and plaster. They have proved successful in many of the largest and most modern buildings in the world. They hold in any wall, it is claimed, making reinforcements, such as studdings, unnecessary.

Sauerman Bros., Chicago, Ill., have just issued a *Circular, No. 124,* describing and illustrating the new and larger Sauerman portable scraper unit. This machine consists of a scraper bucket, operating cables, guide blocks, bridle anchorage system, and portable hoist. The outfit is furnished with a 35 h.p. Sauerman gasoline hoist, 25 h.p. Sauerman electric hoist, or belt hoist designed for operation by a 25 h.p. electric motor or tractor. A special feature of the hoists is the interchangeability of the driving power. A gasoline outfit can be changed to electric by replacing the engine with the proper electric motor, or vice versa.

Is Street Railway Paving One of Your Problems? Bulletin of the W. S. Godwin Co., Inc., Race and McComas Streets, Baltimore, Md., carrying a reprint of an article from *Electric Railway Journal* of January 19, 1924, showing various causes of failure of bond between paving and rail under traffic, suggesting a possible remedy in the use of the Godwin steel joint strip so that the rail will be carried independently of the paved surface, separated from it.

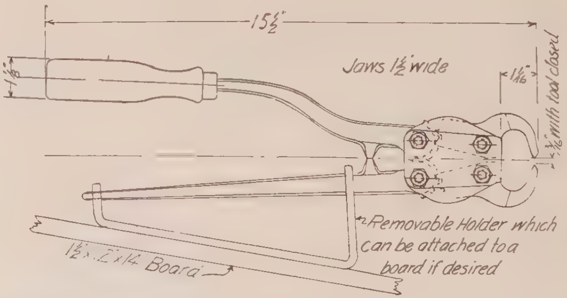
Bo Process. Products Manufactured from Purified Cinders, the Cinder Products Corp., 416 Union Trust Building, Rochester, N. Y. A pamphlet describing in detail the development of a process for the purification of steam boiler cinders in order to make available a special aggregate for the manufacture of concrete products. The book describes the advantages of cinder products in general for building units and the Bo process cinder products in particular. This booklet is accompanied by two circulars, "Tests on Bo Brick, Bo Block and Bo Tile," which gives the results of a number of tests for compression, transverse strength, absorption, compression after immersion, fire test, freezing test, and others on Bo products, and another circular illustrating the use of Bo cinder products in building construction.

The T. L. Smith Co., Milwaukee, Wisc., is distributing its 1924 paver catalog. It contains complete descriptions of the Smith paver models and their outstanding features, together with many half and full-page illustrations of Smith pavers in action. This year's catalog is especially attractive, being printed in three colors throughout and having an extra strong binding.

Road Building and Contractors' Machinery—the Oberlin Machinery Co., Oberlin, Ohio. Eight 6 x 9 pages illustrating and describing the Little Yankee, the Ohio Leader, the Ohio Utility, the Ohio Standard, Two-Blade and Three-Blade Drags. They aim to cover the field in this line of equipment for road building.

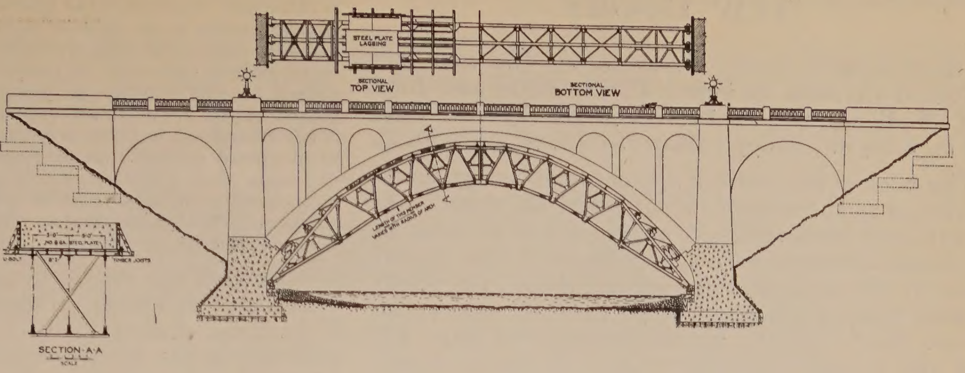
The Hug Truck, for use on the road job is described and illustrated in a circular issued by the Hug Company, Highland, Ill.

To Cut Concrete Roof Tile


15½"
1⅛"
Jaws 1½" wide
1¹⁄₁₆"
³⁄₁₆" with tool closed
Removable Holder which can be attached to a board if desired
1½" x 2" x 14" Board
Material-Drop forged steel
1¼" Maximum opening of jaws
Total weight of tool & holder 4¾ lbs
Extra set of jaws with each tool

This picture illustrates a tool (Crawfordsville Foundry Co., Indianapolis) for cutting concrete roof tile. Tile is sometimes cut while green in making, but that is not always possible, because roof angles vary.

Fig. 1—Labride System of Adjustable Steel Centering for Concrete Arch Bridges



Adjustable Steel Centering for Concrete Arch Bridges

The accompanying illustration shows the Labride system of adjustable steel centering for concrete arch bridges and the method in which the centering is used during construction. The system consists in placing any number of steel ribs at intervals of 5 ft. parallel to the axis of the bridge and rigidly braced together. These ribs carry transverse beams which in turn support a steel plate lagging upon which the arch ring is poured. Each rib is composed of two end sections between which may be assembled any number of like units depending upon the length of the rib required. The units are triangular in shape, their bases conforming to the curve of the arch ring and their apices connected by a member whose length is adjustable. This permits the radius of the rib to be adjusted to any degree of curvature. The equipment, it is pointed out by the manufacturers, is adjustable to meet the three variable conditions of concrete arch design, i. e. width of bridge, length of span and radius of the arch.

The principal advantage claimed by the manufacturer is economy. Every unit may be used repeatedly for any length, width and rise of arch with the result that there is no salvage material. This fact, it is claimed, enables the company to lease the equipment during the period of construction at a much lower cost than that of timber false work or specially built steel centers.

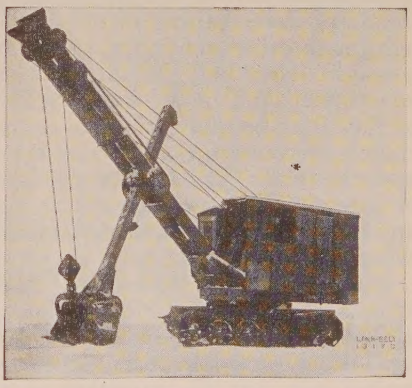
Since all the units required for a job are regularly carried in stock at the company's fabricating plant, immediate shipment can be made and the parts erected by the erection crew in much less time than is required to erect timber falsework making the system advantageous to the contractor who must complete his work in the shortest possible time. The units are all designed for long spans and heavy arch rings and the strain imposed upon them by the average construction is considerably less than that allowed by good structural practice.

The Labride system is manufactured by the Lakeside Bridge & Steel Co., North Milwaukee, Wis., and is leased to contractors for use during construction. It is erected and dismantled by the steel company's own forces and is not sold outright. Erection work may be done by the contractor under the company's supervision. The rental charge is based largely upon the nature of the work, the amount of equipment required and the length of time it is in service. The system is not applicable to the concrete girder type of bridge and is not recommended for extremely flat, short span arches.

Shovel Attachment for Gasoline Crawler Crane

A shovel attachment for use in connection with Link-Belt gasoline crawler cranes has recently been developed by the Link-Belt Co., Chicago. This shovel boom-attachment is interchangeable, and provides the crane with a far greater field of usefulness. Either attachment (shovel or crane boom) can be specified as original equipment, but, however specified, are interchangeable.

The dipper is ¾ yd. capacity and is made entirely of manganese steel. The standard dipper stick is 15 ft. long. The boom is 24 ft. center to center. All crowding motion is performed by a rack and pinion, actuated by a combination of the hoist and hold rope used on the ordinary clam shell bucket hoist. The full power of the 60 h.p. gasoline engine can be used in the crowding motion.



Link-Belt Crane with Shovel Attached

The crane can be readily and at very small expense changed for clam shell, drag-line bucket, shovel or pile driving work.

Products Manufacturers—what success are you having in your territory in keeping up the general quality of concrete building units? Tell the Editors your experience.

New Books

Portland Cement Prices, Their Basis, Character and Present Position, by Henry Parker Willis and John R. B. Byers, Ronald Press Co., New York. Size, 5 in. x 7½ in.; 123 pp.; illustrated; cloth, price $1.25.

This book is the result of a scientific investigation of conditions in the cement industry and the question of fairness and reasonableness of prices and an analysis of cement company earnings. The work was undertaken by the authors at the request and in the behalf of some leading producers of portland cement in the eastern district of the United States, who have felt that the actual facts with regard to the economic conditions by which portland cement prices are determined should be made available. The authors assume all responsibility for the statements both of fact and opinion included in the book, and they offer them as the result of careful examination of price quotations, as well as other data obtained from all accessible sources. The final expressions of opinion presented are those which have been independently reached by the writers.

The analysis of cement prices and the economic processes by which they are determined has been referred to by Thomas Sewall Adams, professor of economics, Yale University, as a valuable collection of data, bearing not only upon the cement industry and the determination of cement prices, but also upon the meaning of uniformity and stability in prices; the relation of the latter to combination and competition in price making; the tests or criteria of fair prices, normal prices, competitive prices; finally, the amount, rate, and reasonableness of the profits which eastern cement producers have realized in recent years.

In cement, as in other industries, prices are quoted in various ways. They may be obtained direct from the manufacturers, and may then exclude freight charges, or they may be quoted f. o. b. certain points, e. g., the points of consumption. Prices may be regularly quoted in trade journals or by government agencies or bureaus. There will always be slight differences of amount or of methods of statement, and the authors explain as exactly as may be possible, how portland cement prices are determined and quoted, and examples are given of all the regular sources of cement prices, in order to enable the reader to form his own conclusions regarding their movements.

It is pointed out that the summary of the prices received by a large number of cement producers indicates competition plays an important part in the fixing of their prices in various markets. For the purpose of indicating the various forms of competition, a few typical cases are given, it being evident to the authors that the public is not familiar with this side of the business, and that this is probably the first time that these facts have been thus presented.

As to the causes of price uniformity, Professor Adams states:

> Perhaps the most important part of this monograph is its keen analysis of the causes and significance of "uniformity and stability" in cement prices. Here, the first point to be noted is that, to the producers or sellers, there is no real uniformity. In any given market, the prices quoted by different producers are likely to be substantially the same on any day, but these prices are f. o. b. destination or delivery point. The producers absorb the freight charge. That means that if producer A absorbs a freight charge of 40¢ per barrel, producer B one of 50¢, and C one of 80¢, the net mill prices received by producers A, B, and C will vary, because of freight charges alone, by 40, 50, and 80¢. Obviously, there is no pooling agreement by which territory is subdivided in such a way as to yield producers approximately the same prices at the respective points of production.
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> Prices to purchasers of cement, however, are likely to be substantially uniform and comparatively stable. There are ample reasons why, under competition, they should be. First of all, cement is thoroughly standardized or uniform, and nobody charges that this standardization is the result of monopolistic combination. Terms of sale have come to be similarly uniform. Price quotations are mailed or telephoned frequently to prospective customers, and the prices quoted by one producer are quickly communicated to other producers. There are no future dealings in this industry. Under such circumstances, it is price diversity rather than price uniformity which should naturally arouse suspicion. Why purchaser X should pay more than purchaser Y for exactly the same product, sold under exactly the same terms, is difficult to understand. And how producer A could get more than producer B under these conditions, is equally difficult to explain.

Appended to the discussion of portland cement prices are: a history of portland cement, tabulation of portland cement prices from all available sources, and tabulations of prices of other commodities compared.

Organizations

American Concrete Institute; Harvey Whipple, Secretary 1807 East Grand Boulevard, Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Commission; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

The National Concrete Stave Silo Association; W. G. Kaiser, Secretary, 111 West Washington St., Chicago.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., N. Y. C.

The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, Genera Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.

Two of the 2 to 3 ton 4-cyl. Autocars owned by W. S. Morrison, of New Brighton, Pa., who has been building highways with Autocars for three and one-half years.

Autocar motor trucks, because of their short wheelbase handiness and their tremendous power and stamina, are regarded by contractors and highway officials as the standard equipment for modern highway construction work.

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EITHER OR BOTH - AS YOUR WORK REQUIRES

Capacities from 1 to 6 tons

Krodeproof as a Protection for Steel and Concrete

The value of asphalt in protecting steel from the attacks of acids, acid fumes, and corrosive gases is made use of in Krodeproof, manufactured by Gardiner & Lewis, Inc., 30 Church St., New York City. The manufacturers claim that the problem has been to find a means of depositing such an asphalt coating on the metal economically without special heating equipment and without highly skilled labor, and that it has been solved in the emulsification of asphalt with water. The asphalt is broken up into minutely fine particles in the presence of water, the resulting product being a creamy, paste like substance readily spread on the steel or concrete surface with a brush or spray. When spread, the water evaporates, leaving the asphalt particles to flow together and unite in a continuous asphalt sheet.

The following properties are among those claimed for Krodeproof by the manufacturers: This coating may be applied to any metal surface. It can be applied directly to galvanized iron without pickling or other preliminary treatment. It may be applied directly to wet surfaces as well as dry. It is absolutely and permanently waterproof. It gives perfect protection against locomotive gases, brine drip, acid fumes, and corrosive gases generally. Under average drying conditions it will set in a few hours. It gives off no noxious odors or fumes, and may be used with perfect safety in confined spaces. It is absolutely non-inflammable. Unlike asphalt paints, it will neither burn nor explode.

The material is recommended by the makers for special uses in connection with steel structures in railroads as protection against brine drip from refrigerator cars and against locomotive gases. It is also recommended for the interior of paint cars used for the transportation of acid-carrying liquids, such as sulfite liquor. Other special uses include electrolytic tanks, coal bunkers, and hydro-electric work.

A. G. C. Chapter Compiles Building Costs

The valuation committee of the local chapter of the Associated General Contractors of America recently completed a compilation of the average building costs in Southern California at the end of 1923.

The information in the compilation will be used by the county assessor as an aid in determining the correct valuation of buildings. It will also be used by the mortgage and loan departments of many local banking institutions as a guide to the accurate appraisal of structures.

The News Letter of the Associated General Contractors summarizes the costs as follows:

Class A steel frame buildings—Cost per cu. ft.: Office buildings, 53¢; hotels, 58¢; lofts, 28¢; warehouses, 25¢.

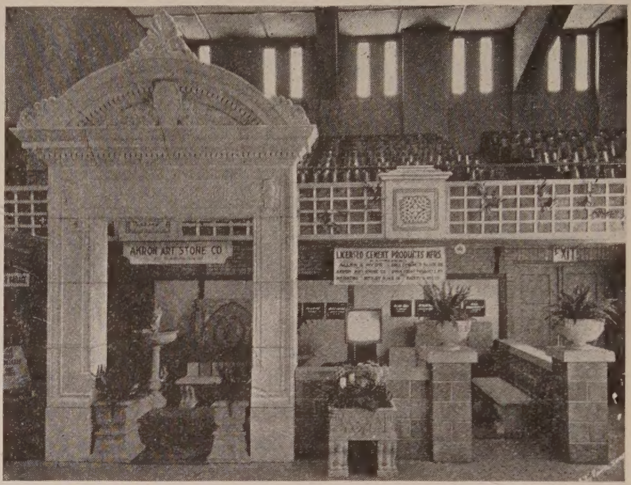
Class A reinforced concrete buildings—Cost per cu. ft.: Office buildings, 50¢; hotels, 55¢; lofts, 25¢; warehouses, 20¢.

Class C brick buildings—Cost per cu. ft.: Stores or theaters on ground, rooms, apartments, etc., above, 33¢; apartments, 38¢; lofts, 20¢; warehouses, 15¢;. One-story garages, per sq. ft., $1.75; one-story stores, per sq. ft., $2.25.

Frame buildings—Cost per sq. ft.: California houses, good, $3; medium, $2.50; cheap, $1.75. Bungalows, special, $5 to $6; good, $3.60; medium, $3; cheap, $2.50. Bungalows, out of town (no restrictions), good, $3.75; medium, $2.75; cheap, $2. Residences, two-story, good, $6 to $8; medium, $4.50; cheap, $3. Outbuildings, good, $2 to $2.50; medium, $1.70; cheap, $1. Corrugated iron buildings, all kinds, approximately $1.

The Class A construction referred to is fireproof construction, such as reinforced concrete, or structural steel with all its structural members protected with fireproofing material.

Products Exhibit at Akron



Concrete products were attractively exhibited at the recent Akron, Ohio, builders' show, held ten days in the Akron armory and attended by more than 50,000 people. A half-dozen Akron firms handling concrete products pooled their interests and presented the display shown in the accompanying illustration. The show was participated in by 70 Akron building supply and lumber men, and was very successful.

If you tried something new—a new way of doing the job—and it worked, pass the idea along. Nobody can stand alone on his own experience.

Tell the Editors of CONCRETE and swap your idea for the many new ideas of "the other fellow".